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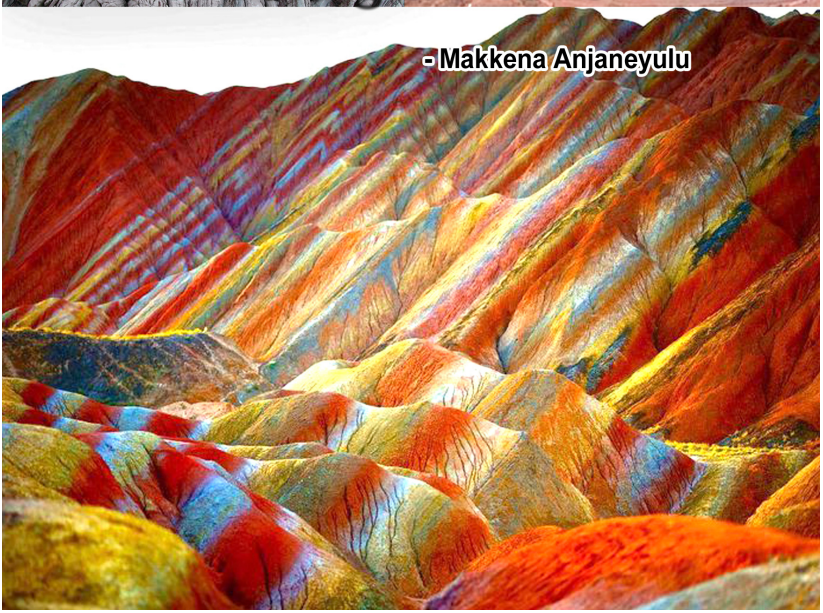
Descriptive Terminology of Geological Items

- Makkena Anjaneyulu



Descriptive Terminology of Geological Items

Author : **Makkena Anjaneyulu**

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Retd. Assistant Director, APGWD,
Chandaluru, J.Pangulur (M)
Prakasam Dt., A.P.,
Cell : 9701833760

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M. Anjaneyulu
The Author

PREFACE

This book deals with the definitions and illustrations of important geological items. The author is of the opinion that every field officer must acquire the knowledge of the rocky terrains and investigations pertaining to any category of geological surveys. Keeping this in view important aspects of geology has been presented in an easy understanding mothodology so that to inculcate the knowledge and dissminate among investigating faculties and others who are interested in the subject. It provides a basic foundation to propel into the deeper levels. This book may also be considered as the panel of geological items and paves the way for the reader to obtain perceptual view of the subject.

M. Anjaneyulu

The Author

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I. EARTH :

The third planet of solar system lying between mars and venus. It may be considered as the part of universe with 16 inter mingling condition of water air and land making possibility for the existence of the life in present terrestrial globe. The earth is surrounded by the envelope of the gas, atmosphere. It is divided into layers of different densities as per the temperature changes. The earth mainly contains 3 layers namely crust, mantle and core.

The earth is roughly elliptical in shape. The average density of the earth is 5.517%. Water covers 70.8% of earth's surface. The land is unequally distributed on the globe. The land itself has a generally concentric arrangement, with the mountain ranges fringing the continents and old crystalline rocks out cropping in the centers. The Himalayan region of Asia is the highest land, mount Everest (8840m) being the highest peak.

The oceans may be visualized as a series of basins separated by ridges. The ocean floors are usually covered by 1-3 km of sediments. From them rise mountains of volcanic rocks in whole ranges, with lines of cone or isolated peaks of basaltic lava.

II. MOON :

Moon is the natural satellite of the earth. It revolves in an elliptical orbit around earth at a mean distance of 383403 km.

Appollo II astronauts landed on the moon on July 20, 1969 of all the satellites in the solar system, moon is the largest in proportion to its primary.

As can be seen from the earth with the naked eye, the moon has two major types of surface the dark smooth maria and the lighter, rougher high lands. Photography by spacecraft shows that for some unknown reason, the moon's far side contains mainly of high lands. Both high lands and maria are covered with craters of all sizes the craters are more in the highlands than in the maria. Most prominent at full moon are the bright ray craters.

Rocks returns by the Apollo astronauts are covered with tiny glass pits conforming erosion by small high speed particle. According to one theorem occured the size of the moon is the same as pacific ocean and hence. The detachment of moon might have theory occured from this place of earth.

III. BRANCHES OF GEOLOGY

1. Crystal Chemistry : This it the most vital part of mineralogy and is the basis for the other studies. The other fields of mineralogy, crystallography, petrology geo-chemistry are connected in the domain of crystal chemistry.

2. Engineering Geology : The application of education and experiences in geology and other geo-science t solve geological problems posed by civil engineering structures of five mainly concerned with (a) Surfacial geology (b) petro-fabrics (c) rock and soil mechanics (d) geo-hydrology (e) geo-physics.

3. Geo Morphology : It is the study of the origin of secondary topographic features which are (a) carved by erosion in the primary elements (b) built up of the erosional debris.

4. Geochemistry : It is concerned with chemical elements that make up the earth and with the chemical reactions which produce and alter the elements.

5. Geodesy : A sub-division of geo-physics which includes the determinations of science and shape of the earth.

6. Geology : The study of earth which mainly deals with the nature of earth materials and their processes of changes during geological periods at different stages.

7. Geophysics : This is the branch of earth science in which the principle of physics are used to study the earth in different ways.

8. Hydrogeology and Geo Hydrogeology : Hydrogeology encompasses inter-relationship of geological materials and

process with water.

Geo-hydrology is restricted to the engineering field dealing with hydrological problems.

9. Marine Geology : It deals with the continental drift, continental slope, continental shelf, sub-marine canyons and sea floor spreadings.

10. Mineralogy : It is the study of natural inorganic substances which are called as minerals.

11. Nuclear Geology : It deals with the nuclear elements such as uranium, radium, thorium, pitch blende, half-life period, atomic energy of nuclear logging for ground water prospecting.

12. Paleontology : It deals with study of animal history as recorded by fossil remains and other elements (a) Determining ancient earth's appearance (b) Evolutionary process and life history (c) Paleosols etc.,

13. Pedology : It is the system of soils. Soil structure is inferned to the arrangements of soil particles into aggregates or peds of different sizes and shapes. The study of soil structure is more important in drainage patterns salt tolerance and other factors of fertility.

14. Stratigraphy : It is the branch which deals with the layered or stratified rocks. Mainly it concerns sedimentary rocks and also layered igneous rocks such as lavas and tuffs and also metamorphic rocks that are formed from volcanic and sedimentary rocks.

15. Structural Geology : It is the branch of geology which deals with description and analysis of the form inter-relationship of rock bodies.

IV. IMPORTANT GEOLOGICAL PROCESSES AND RESULTING LAND FORMS:

1. Arnaceous Rocks : Include all these clastic rocks whose particle size range from 2 to 1/16nm. Some oolitic iron ores of gloconite beds are properly classified as “Arenites”.

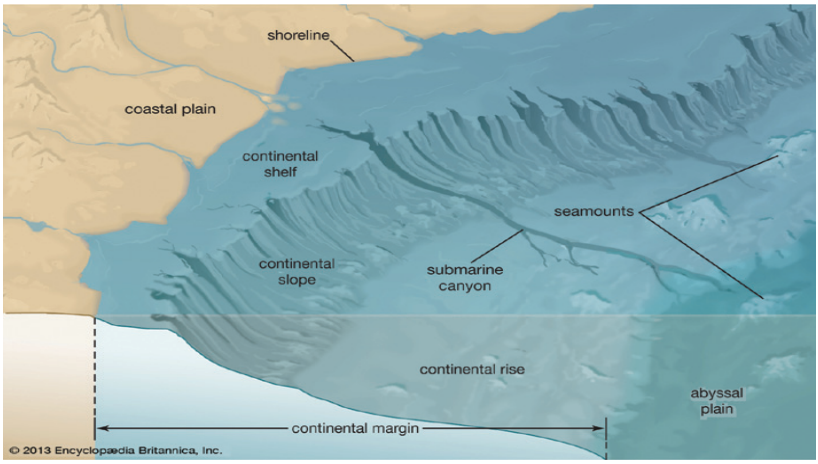
2. Argillaceous Rock : These rocks includes shales, argillites, silt stones and mud stones. They are the most abundant sedimentary rock type. Clay stones comprise hydrous aluminium silicates.

3. Arkose : Arkose is classified under arenites compose of sand size fragments. It is also known as feldpathic sand stone.

4. Continental Drift : Generally the continents are coupled with large fragments and are oceanic crust on the cooler lithosphere. Great fragments or plates of the lithosphere appear to jostle and move over the softer and melted upper mantle of the earth.

The most obvious evidence of continental fragmentation and drift is derived from the shape of the continents and their submerged border lands. One of the most imposing and significant features of the sea floor is the ridge and rise complex. This is a vast largely sub marine mountain chain dotted with numerous volcanoes. The complex is world's girdling extending some 60000 KM largely through the median parts of ocean basins.

5. Continental Shelf and Continental Slope : Continental shelf is the zone around the continent extending form low water line to the depth at which there is a marked increase in slope to greater depths. The continental slope is the declivity from the edge of shelf extending down to greater oceanic depth. The shelf and slope comprise the continental terrace which is the submerged fringe of the continent. Generally the continental slope are downward edges of the low density granitic or static continental masses.



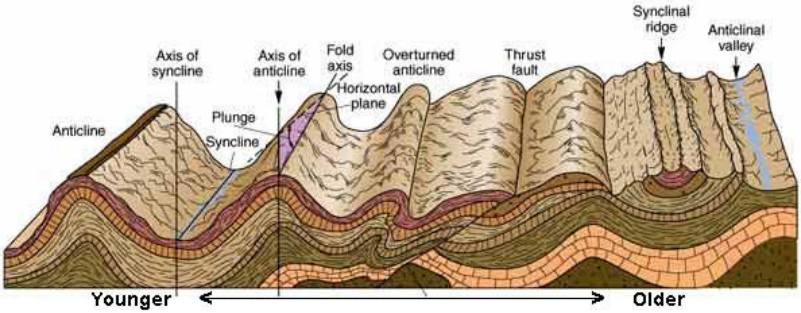
6. Delta : Delta is the deposit formed either at the mouth of the river or tidal indexes. Because of the triangular units in appearance, the greek letter "Ä" was first used for the sediment at the mouth of sub-marine canyan.

7. Desert Land Forms – Aeolian Deposits : Topographic feature generated by wind, the most commonly seen land forms are sand dunes created by transportation and accumulation of windblown sand.

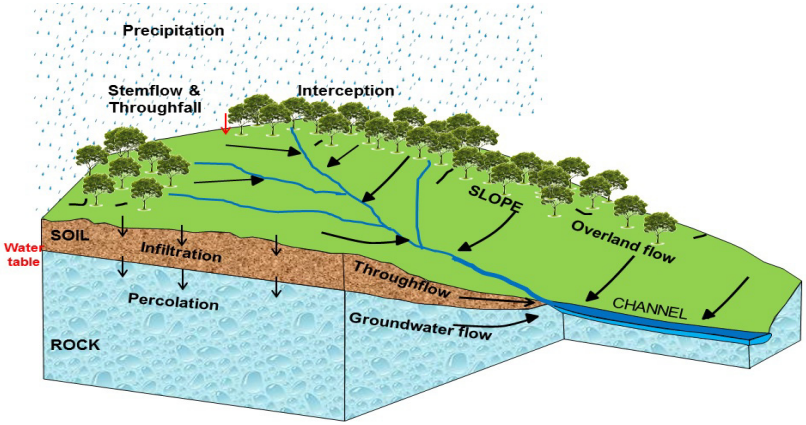
Blankets of wind deposited loess, consisting of fine grained silt are less obvious than dunes, but cover extensive areas in some parts of the world.

8. Diastrophism : The general processes of combination of processes by which the earth crust is deformed. Both orogeny (mountain building) and epeirogeny (continent making)causing uplifts and depressions that effect the wide segments of the earth crust. Diastrophic effect in the geological time both topographic and structural

Diastrophism, earth deformation has direct or indirect effects on sedimentation. The tectonic formation of sedimentary basin provides a place for the deposition of the material.

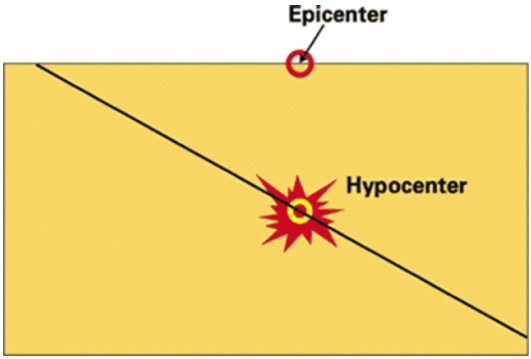


9. Drainage Basin : It is a low lying area wholly or largely surrounded by higher land. Basins vary from small nearly enclosed valleys to extensive mountains rimmed depressions. The term is applied to the drainage basin to the entire area drained by given steam and its tributaries.



10. Earthquakes : A phenomenon during the occurrence of which the earth's crust is set shaking for a period of time. The shacking is caused by the passage through the seismic waves, low frequency, sound waves that are emanated from the point in the earth's interior when a sudden rapid motion has taken place. The occurrence of earth quake is due to plate motion. The plates move a part a ocean ridges. This result in sea floor spreading.

Due to shaking up of the plates the earth quakes occurred causing tremors from the point of origin. The origin from which earthquake waves start is called hypocenter and the distance to the surface point is called epicenter. The intensities and magnitude causing tremors are studied in the form seismograph on rictor scale.



11. Faults : Faults are fracture in rock along with the adjacent surfaces are differentially displaced. Some faults are only inches where as others are miles long with displacement thousands of feet. The trace of a fault on the earth surface is a fault line. Its position may be indicated

by an escartament which is a cliff or steep slope of some extent of margin of plateau on the steep face of a symmetrical ridge.

As per the replacement of the hanging wall or foot wall the faults are classified as normal, reverse etc.

a) **Normal Fault :** Downward displacement of the hanging wall with respect of foot wall.

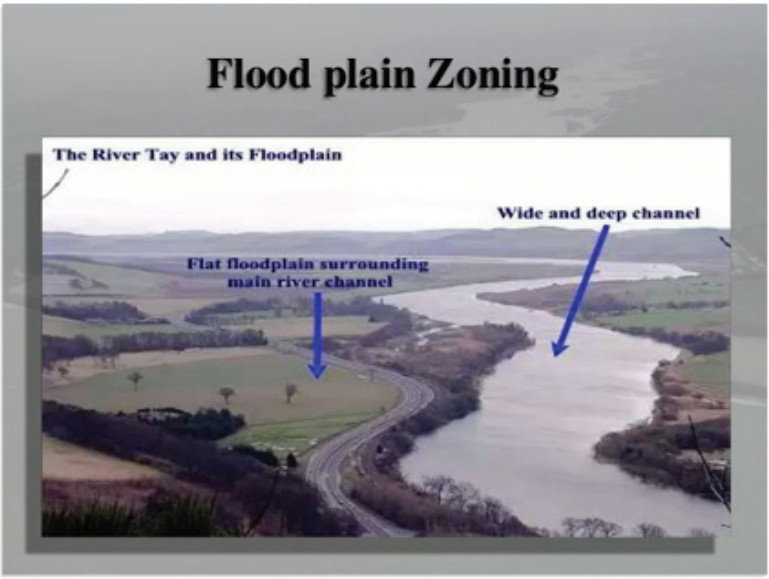
b) **Reverse Fault :** In this upward movement of the hanging wall with respect to foot wall occurs.

c) **Gravity Fault :** In this the hanging wall move downwards relatives to the foot wall.

d) **Thrust Fault :** Hanging walls moves upwards relative to the foot wall.

12. Flood Plains : The valley floors formed by alluviating rivers which are subject to over flow. They may be narrow between the valley walls of a small stream or extremely wide. Towards the flood plains may grade into deltas in

deltaic coastal plains. In some cases, dykes and drainage canals prevent or restrict natural flooding, but in protecting cities and habitations, they rob flood plains of the beneficial effects of overflow.


Flood plain Zoning
The River Tay and its Floodplain
Wide and deep channel
Flat floodplain surrounding main river channel

13. Folds : Folds are recognized where layered rocks have been destroyed into wave like forms. The axial surface divides a fold into symmetrical parts and the intersection of the axial surface with any bed is an axis. Relatively high point on an axis are columniations and low points are the depressions.

The development of fold system is closely tied to concepts of global tectonics. In plate tectonics in which fold system are formed at converging margins where contents are under ridden by oceanic crust.

Classification of folds :

a) Symmetrical folds have limbs of equal length.

b) A symmetrical folds have limbs of unequal length.

c) Over turned folds are inclined folds in which both limbs dip in the same direction.

d) Isoclinals folds are those in which both limbs are parallel.

14. Fossils : The remains and traces such as foot prints and trails of organisms preserved from the geologic past. Several different modes of preservations are known generally. Only the hard parts such as bones and shells have been preserved, but even the soft tissues are also preserved.

Extinct mammals have been found in the ice or frozen ground of the arctic, where they remained in cold storage for thousand years.

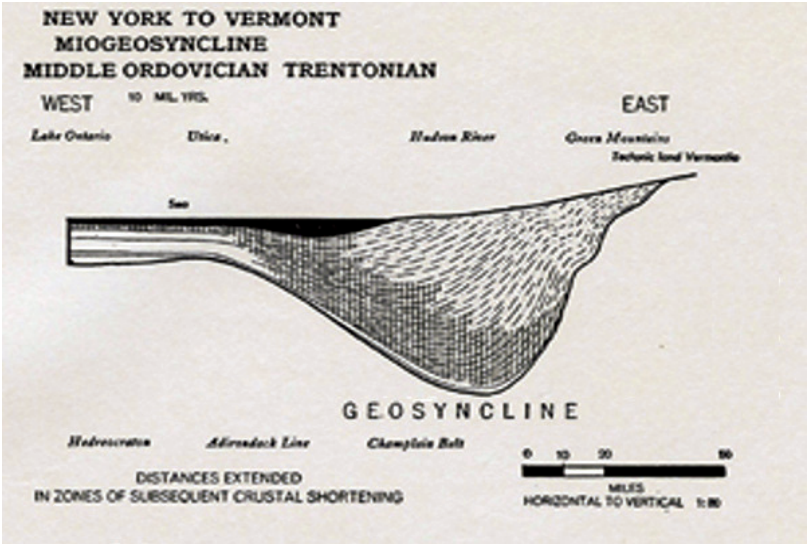
In case of petrified fossils, some organic objects are turned to stone due to the process such as replacement involves the substitution of some other mineral from

underground solutions for the organic material. This commonly accomplished molecule by molecule so that even microscopic structures are preserved where the object is turned to stone.

15. Geological Time Scale : The assignment of time in years to each geological period. The fossils record of life, and the deposition and organic sequence of earth history events provide the basis for the relative time scale universally accepted by geologists.

16. Geo-Syncline : A part of the curst of earth that sank deeply through time traditionally forming a great trough of hundreds of miles long and 10 miles wide and several feet deep.

Synclanorium is great download that was produced by deformation that occurred later than the deposition of the contained rock.



17. Glacier : A glacier is a naturally accumulating mass of ice that moves in the processes of discharging from head of centre to its margins or terminal dissipation zone. Glaciers are nourished in the areas of snow accumulation. The most active glaciers are found in the areas of heavy snowfalls. Glaciers consists of three substances snow, firn, and ice.

18. Granitization : The process whereby various types of rocks may be converted in the solid state to granite or closely related metamorphic material such as granodiorite. The process is large scale change and is considered to have operated inorganic zones (zones of old mountains) contemporaneously with metamorphism. Here stratified undergoing re-crystallization and re-consistution may suffer changes in bulk composition converting them to granitic rock character.

19. Ice-Berg : A large mass of glacial ice broken off and drifted from parent graciers or ice shelves along polar areas. Ice-berg should be distinguished from polar pack ice which is sea ice or frozen sea water.

20. Karst Topography : Under humid climatic conditions, destructively developed land features resulting from sub areal and underground solution of lime stone occurs. These pattern features are progressively carved into second order structural forms such as plains, plateau, even hilly or mountainous upland containing lime stone layers at or near the surface.

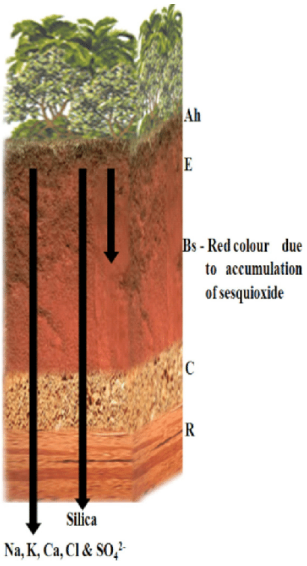
Favouring factors of combination involved produce a land scape. Where a Karst topography (cavernous) has developed, most surface waters disappear quickly by entering sink holes.

Two types of sink holes may be observed. The doline and ponor, doline is a saucer-shaped depression with hundred feet of diameter. Ponor type this result from failure of a solution chamber roof whose collapse produces the surface pond sink hole. Both the sink hole are favourable for ground water accumulation. Forming caverns (Caves) and sink holes may be attributed to the process of karstification.

Forming carvern (Caves) and sink holes may be attributed to the process of karstfication.

21. Land Slide : The perceptible down ward sliding or falling of a relatively dry mass of earth, rock of combination of the two. The term is sometimes extended to cover related fringe movement including earth flow, mud flow and debris avalanche.

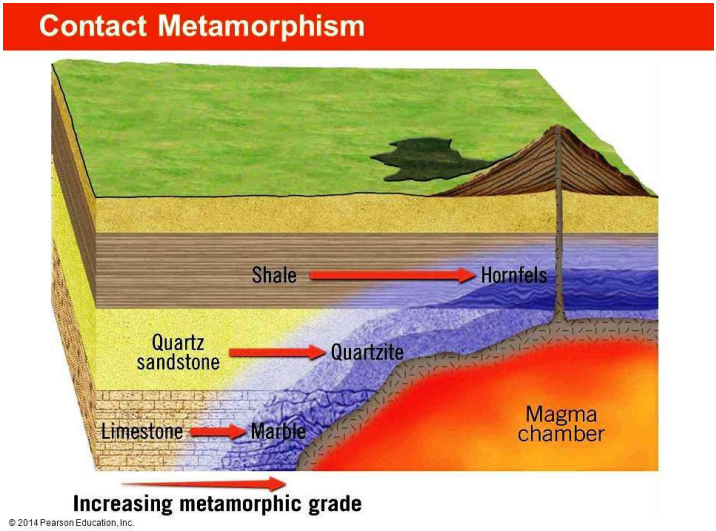
22. Laterization : Laterite is formed by weathering under conditions that lend to the removal of silica, alkalies and alkaline earth's. The resulting concretions of iron and aluminium oxides sharply differentiate laterization from temperature, climate, weathering in which the end product is largely clay minerals aluminuos laterites are composed of gibbsite and boehmite and is the principle ore of Aluminium. Concentrating forms of varying sizes and shape are commonly developed. The colour depends on the content of iron oxides and ranges from white to dark red.



23. Magmatism and volcanism: Magma may be considered as a molten material rock formentations, beneath the surface of the earth, it is called as magma. The process of causing intrusions into the existing rocks are the resulting crystallization of the rock and such as gabbro, granite etc is called magmatism. If the same magma erupted during volcanic eruptions it is called as lava and the resulting rocks such as basalt etc. This process that takes place above the surface of the earth may be considered as volcanism.

24. Metamorphism : At higher temperatures and pressures important changes take place in the mineralogy and texture of most sedimentary rocks these changes are termed metamorphism. And lead to the formation of

metamorphic rocks. It is not restricted to the sedimentary boundary, it may extend to the intrusive of igneous activity and that produce the products of contact regional mentamorphism.



25. Metasomatism : A process by which the chemical composition of rock is altered. Every transformation of minerals by chemical replacement may be designated as metasomatism and in this sense most of the newly form consistuents of the metamorphic rocks would be metasomatic minerals, metasomatism is fundamentally a change. Atom for atom in a rock mineral.

In this context, metamorphism may be viewed as the alteration and transformation in pre-existing rock masses effected by temperature and pressure, but excluding the changes produced weathering and sedimentation.

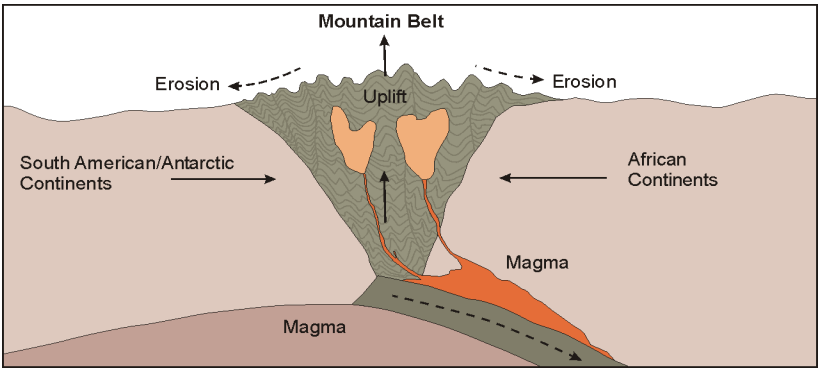
26. MOHS Scale of Hardness : Minerologist often use a relative scale or MOHS scale based on 10 minerals in order of increasing hardness as given below:

Talc	**- 1**	**Photash Feldspar**	**- 6**
Gypsum	**- 2**	**Quartz**	**- 7**
Calcite	**- 3**	**Topaz**	**- 8**
Fluorite	**- 4**	**Corrundu**	**- 9**
Apatite	**- 5**	**Diamond**	**- 10**

27. Optimum Weathering – Favourable for Ground Water Accumilation : Every rock suffers weathering. There are two types of weathering Physical and Chemical. In case of Physical weathering disintegration occurs rendering the formation to undergo favourable mesh of openings for the accumulation of ground water. But in case of chemical weathering, alteration of minerals in the formation take place which leads to the close of the openings and hence hinders the infiltration there by causing the least accumulation of ground water with poor quality. Hence optimum rate of physical weathering is favourable for the formation of favourable ground water reservoirs.

28. Orogeny (mountain Building) : The process by which mountainous tracts such as alpine-himalayan belts or formed are known as orogenysis. Orogenic belts are long and liner with distinctive zones of sedimentary patterns.

During the course of movement of plates oceans basins may be closed as continents collide and leading edge of continent may become crumpled as oceanic crust is pushed beneath the edge of a continent. In either case, mountain chains are created.



29. Paleo-Channels : Old channels of the rivers and other natural valleys whose directional trend of the mouths are closed due to some reason another. Hence the change of present stream take different root in the surfacial layers feeding the old path of the valley which is buried. Hence the buried channels are potential for ground water development in alluvial tracts of rivers.

30. Permafrost : Perennially frozen ground occurring where ever the temperature is below 0 degree centigrade for several years. About 25% of earth's contains permafrost.

31. Petrogenesis and Petrography (Important of Geology in Eng Works) :

Petrology : The study of rocks, their occurrence, composition and origin. Petrography is concerned primarily with the detailed description and classification of rocks, where as petrology deals with the rock formation petrogenesis. A petrological description includes definition of the unit in which the rock, its attitude and its structure, its mineralogy and chemical composition, and conclusion regarding its origin.

Petrogenesis : It deals with origin and occurrence of the different rock formations namely magmatic sedimentary and metamorphic.

Petrography : The orientation of the minerals in the layered rocks of different categories such minerals of the rock exhibit similar characteristics of deposition and environmental features. It is the common features in sedimentary.

a. The application of items of Geo-Science in Engineering, Engineering properties of the rocks : Consideration of most hard and compact nature of rocks and their derivatives of earth's crust. Which are formed by weathering process as soil.

For the purpose core samples of rocks may be studied. The rock properties are compressive shear strength, permeability, Young's modules of elasticity, erodability under water action and density. In most

increase in moisture content in rock decreases the compressive strength and elastic modules for example, the clay cement among grains lower the strength of the rock.

b. **Geo-Technical Significance of the Soils :** Clay supporting structures may consolidate slowly over longer period and cause structural damage silt may settle rapidly under quick condition when saturated.

c. **Petro Fabric Analysis :** The term fabrics denotes collectively all the structural and spatial characteristics of rock mass. The fabric elements are classified into two groups.

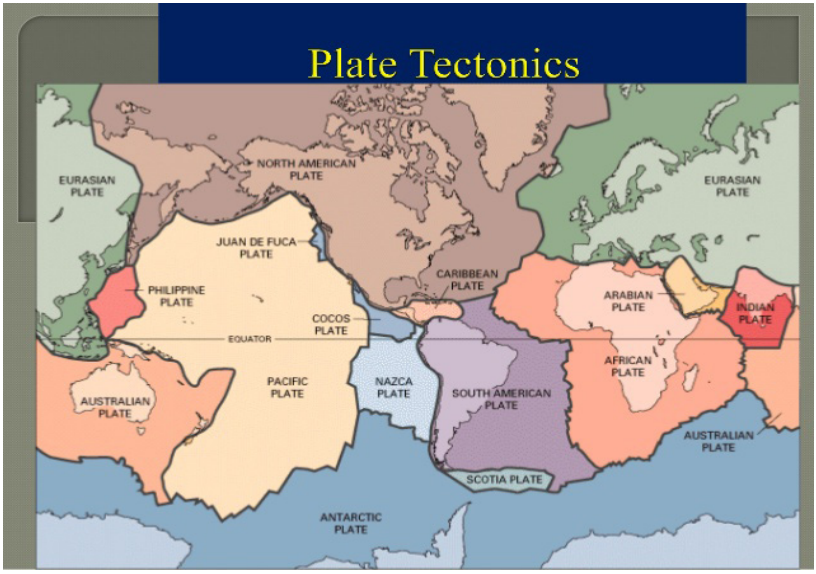
i) Megascopic features including bedding history, foliation, cleavage, faults and joints and minerals lineations.

ii) Microscopic features which include shapes, orientations and mutual arrangement constituent mineral crystals from all the above data we can assess deformation of mineral assemblage and their orientation.

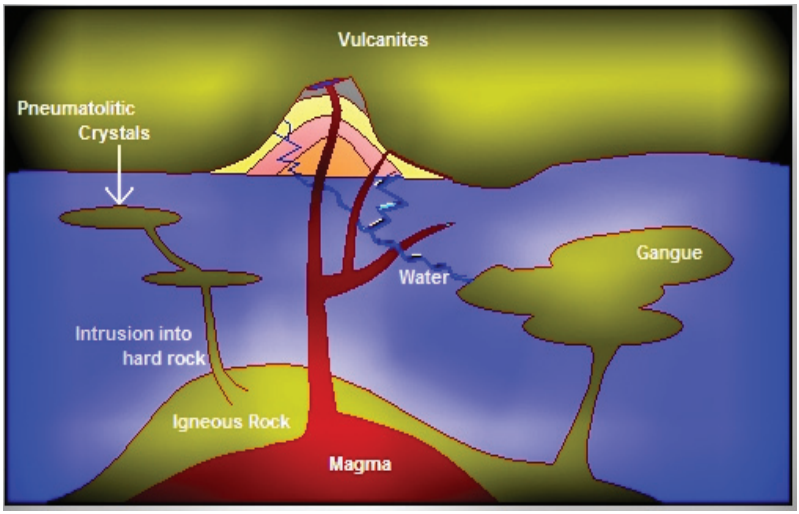
d. Geo-hydrology with respect to soil and weathered condition at the rock and their disposition in respect of the aquiferous zones.

e. Geo-physically, the strength of the rocks may be studied with respect to resistivity and weathered conditions.

32. Plate tectonics : Plate tectonic theory provides an explanation for the present day tectonic behavior of the earth particularly the global distribution of mountain building, earthquake activity and volcanism in a series of linear belts. The plate tectonic model for the earth is consistent with the occurance of sea floor spreading and continental drift. Convincing evidence exist that both these processes have been occurring since last 600 million year. The velocity at which plates move varies from plate to plate. Within the oceans of the same plate ranging between 2 to 20 cm in year.



33. Pneumeotolysis : The alteration of the rocks by the action of magmatic gasses. The gases accompany magmatic intrusions and permit the intruded rocks along fissures and other lines of least resistance.



33. Radioactive Decay - Half – Life : The activity of a source of any radio-active substance decrease one half in the half period because the activity is always proportional to the number of radioactive atoms present in the activity of any radioactive source decreases exponentially with the time "t". Thus the first half-life period A=t/2, next half life period A=t/4, t/8, t/16.

Half life : The time required to one half of a given minerals to undergo chemical reactions. Also the average time interval required for one half of any quantity of identical radioactive atoms to undergo radioactive decay.

34. Ridges, Valleys and Caverns : Ridges are elevated structures of different rock types resembling the local geological structures. Valleys are the depressed v-shaped structures which are affected by the local drainage patterns of the area. Cavern are the hollow structures because of dissolution and leaching up of the materials.

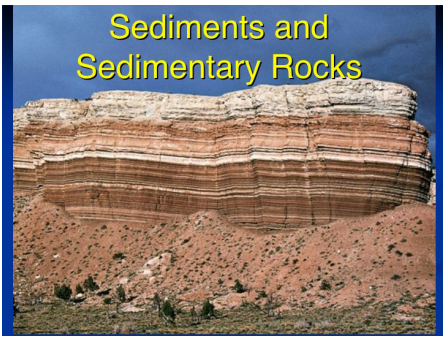
Most of the limestone and dolomites are subjected to dissolution and exhibit karst topography because of kaustification sink holes are formed which are favourable sites for the ground water accumulation. The area of Borra caves of Vizag district near ananthagiri are typical example here the country rocks are calc-gleuconits and caves are formed in the lime stone terrain. Stalactits and stalagmites are also formed at the mouth of burra caves.

35. Sand Dunes and Loess : Desert deposits when abundant loose sand is available for the wind to carry sand dunes develop first shaping of the pile of sand is developed. Sand grains bounce up the wind ward sides of the pile until they reach the crest and then tumble down the lee side in the wind shadow behind the crest. Sand trapped in the wind shadow accumulates until the slope reaches the angle of repose for loose sand. Dunes advance downwind by erosion of sand on the wind ward side and re-deposition on the slip face.

The fine silt and clay from coarsest sand is often blown longer distances before coming to rest as blanket loess mantling the pre-existing topography thick deposits of loess most often found in regions downwind from glacial outwash or alluvial valleys such as missip valley.

Dune

Loess



36. Sedimentation: The process that operate at or near the surface of the earth to deposit rock forming minerals are sediment. Sedimentation includes the weathering processes that mechanically or chemically to break up pre-existing rocks, the process of transportation by which the material is carried from its source to the depositional site, the processes of deposition in the sedimentary environment. The raw materials in this processes may be the products of igneous metamorphic and sedimentary rocks. The carriers are wind and water to the site of deposition.

37. Submarine Canyon : A relatively narrow deep depression in the sea floor with steep slopes, the bottom of which grades continuously downward. The submarine canyans extend out ward down the slope virtually to the deep ocean floor. Many of these have rocky walls of 1000ft high. They have narrow inner gorges, winding courses, numerous tributaries.

The deep floors of the canyans contain sediments alternating between sand which resemble shallow water deposits and normal mud sea deposits. Some of the canyans are direct continuation of land canyans.

38. Unconformities : The relation between abject rock strata whose time of deposition was separated by a period of non deposition or of erosion. The break in the stratigraphic sequence represent a significant change in regimen (in contrast to diastem) thus marine strata separated by a surface of subarial erosion are unconformable.

Types of unconformities :

a. **Non-conformity :** Rock below the break are not stratified.

b. **Angular unconformity :** Rocks below the break are stratified but lie at an angle to those above.

c. **Disconformity :** Strata below are parallel to those above but are separated by an evident surface of erosion.

d. Pseudoconformity or pera conformity : Strata is parallel but surface is hardly distinguishable from a simple bedding plane.

Unconformities are commonly or only chief records in a given straticgraphic sequence of the time elapsed between the deposition of rocks above and below. This time is called hiatus. Unconformities are important in getting the information pertaining to erosion.

39. Volcanoes : An opening in the earth's crust through which magma is erupted (in the form of molten material and gases) it may be fissure eruption or through a cone in which crater eruption is resultant. The magma when it comes out is called lava. During the processes of eruption dikes sills may be formed across and along the bedding planes or conformity along with the bedding planes during the fissure type of eruption small vents may be formed to eject the lave out.

a. **Sub-Marine volcanism :** In shallow water volcanic eruption are similar to those on land except for the virtual generation of the steam. The glassy ash may be formed in this way. At greater depths vesiculation is reduced due to escape of gases from erupting lava.

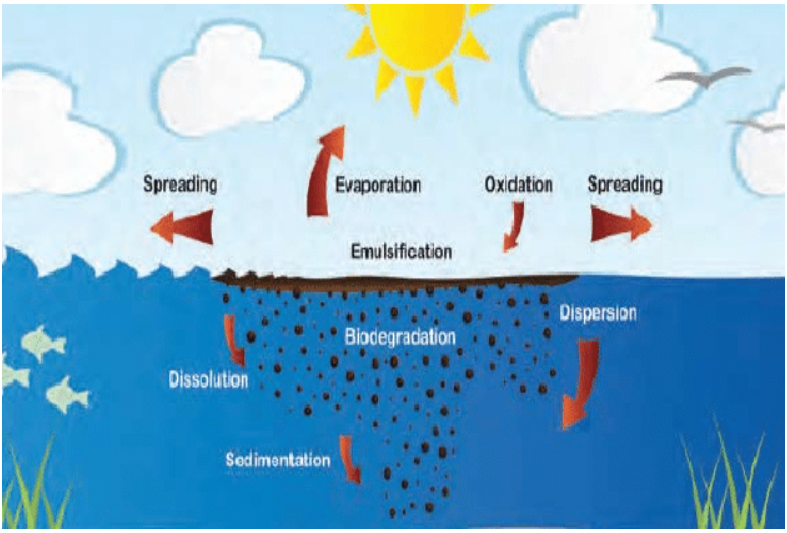
b. **Volcanic Products :** The extruded molten lava converts into either volcanic glass by quick chilling or solid rock by chilling and crystallization. The rock is also termed as lava or lava rock. The character of volcanic eruption depends on the viscosity of liquid lava and amount of the gas in it. Pyroclastic Materials, volcanic glass modules are the main items in the lava flows and their environments.

c. **Fumaroles and hot spring :** Vent which volcanic gases issue without lava are known as fumaroles. The fumaroles grade into hot springs and geysers (intermittent spouting). In hot springs the water is mostly of meteoric origin the thermal spring of geyser of yellow stone park (USA) or of this type in which heat generated from rising hot volcanic gases.

40. Weathering Process : Bed rock and near the earth's surface is subject to mechanical and chemical changes in a complex process called 'Weathering'. Some soluble products of alteration are removed by percolating water.

Weathering prepares the way for removal of rock material and reshaping of land surfaces by several agents of erosion. water and wind are the chief agents to reshape the areas. Under this circumstances, drainage patterns

are more effective in cutting nallahs valleys and eroding soils etc. Wind also play important role in shaping up of the land forms. Dunes and loess are the resulting land forms of wind.

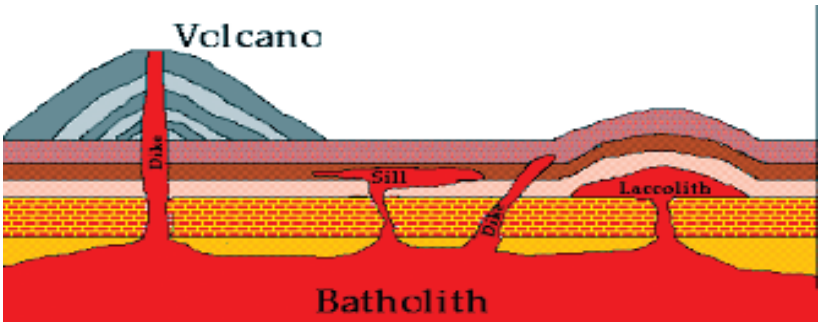


V. IGNEOUS FORMS OF INTRUSIVE BODIES

Plutons : A rock body formed by the consolidation of magma (molten rock) below the surface of the earth but now exposed due to errosion considerable emphasis has been placed on weather the body is concordant or discordant. For example dykes are discordant piercing through the bedding planes whereas sills are concordant following in conformity with the bedding planes. The description of the different injected bodies is given below.

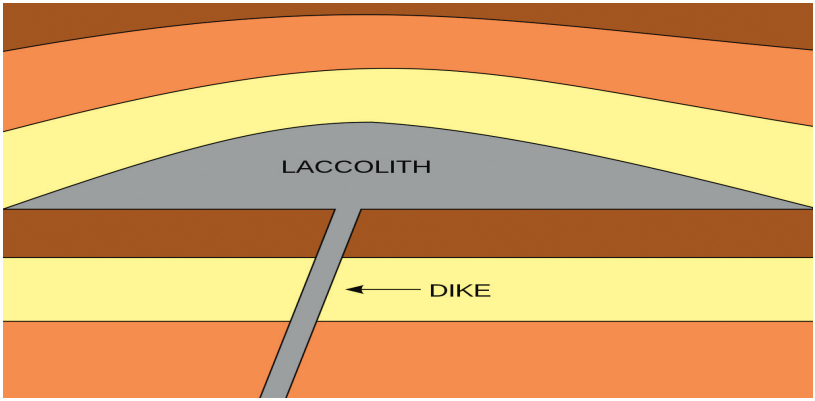
1. Basement Rock : The more resistant rock beneath or irregular deposits of younger and deformed sedimentary strata. The term is also used for basement complex. It consists of pre Cambrian igneous and metamorphic rocks of various type and the sedimentary strata in some cases.

2. Batholiths : Batholiths are the large intrusive bodies of miles consisting of coarse grained igneous rocks.

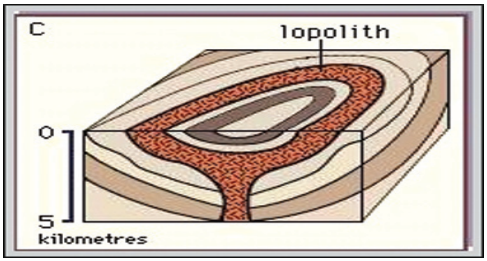


3. Dykes : Dyke is a discordant sheet of igneous rock cutting the adjacent rocks. Dykes form when magma infects a fraction displacing the walls of existing rocks. They are discordant in nature piercing beds in any direction. Ring dykes form in cylindrical fractures of the rocks.

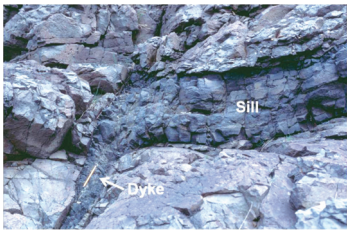
4. Laccolith : It is also concordant mushroom shaped body younger than the adjacent rocks. The overlying rocks are domed up as the viscous lava is injected parallel to the bedding.



5. Lopolith : It is a large concordant sheet of igneous rock younger than the adjacent rocks in the form of a great saucer.



6. Sills : Sills are injected bodies of magma along the bedding planes of the existing rocks. They may be considered as the concordant intrusive bodies along the bedding planes.



7. Volcanic Vents : Vents are sub-circular bodies composed of lava and fragmented volcanic rocks. The vents fed volcanic cones.

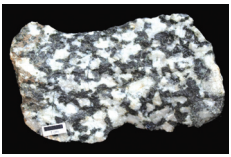
VI. ROCK FORMATIONS

Rock is a relatively common aggregate of mineral grains. Some rocks are constitueted only one mineral such as quartzites which are called as monominerolic rocks. Most of the rocks contain more than one or two minerals. Such rocks are called polymineralic rocks such as granite, gabbro etc. Important rock formations are discussed as follows.

A. Igneous Rocks (Magmatic and Volcanic Rocks) :

1. Andesite : A volcanic rock intermediate in composition and colour between basalt and rhyolite and characterized by excess SiO_2, most andesite is porous tephra. Erupted exlusively from steep-sided volcanoes. Together with basalt, andesite is a principal volcanic rock of island arcs and continental margins.

2. Basalt : An igneous rock characterize by small grain size (less than 5 mm) and approximately equal proportions calcium rich plagioclase feldspar and calcium rich pyroxene. With less than about 20% of other minerals. Olivine, iron-titanium oxide minerals are the most prevalent other minerals. Most basalts are dark grey or black. Basalts are the predominant surficial igneous rocks on the earth. The magnetic properties of basalts are most useful in the assessment of earth's magnetic field and the rate of sea floor spreading. Basalts flow out of fissure and cylindrical vents.

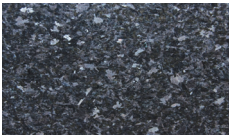


3. Diorite : A plutonic rock with granular texture composed largely of plagloclas felsper with smaller amounts of dark coloured mafic minerals (harmblende, biotite and pyroxin) it is used as ornamental or building stone.

4. Dunite : An ultra basic rock consisting almost solely of olivine. The type locality is Dun mountain situated in the so called mineral belt in Newzeland. Dunite generally form sill and lenses in layered basic complexes such as the bushueld lopolith in South Africa. Dunites are important sources of chromium, magnitite, iliminite, pyrrhotite etc., serpentanization of olivine oil in dunite is wide spread. Dunite may be formed by franctional crystallization of basic magma.

5. Gabbro : A rock made up of centimeter sized crystals mostly of calcium rich plagioclase and pyroxene in subequal amount. Minor amounts of calcium poor pyroxene olivine, apatite, nepheiene or quartz may occur, but not all together luner gabbros are less common on the moon than lunar basalts.

The terms gabbro, diabase or dolerite and basalt refer to mineralogically identical rocks which differ in grain size. There is correlation between grain size and mode of occurrence.



6. Granite : A phaneritic (visibly crystalline) plutonic rock with granular texture, composed largely of quartz and

alkali feldspar with sub ordinate plagioclase and dark coloured mafic minerals (biotite and hornblende). Because of the strength and durability and pleasing colours (pink, red, grey) granite is an important building and ornamental stone.

7. Granodiorite : A phaneritic plutonic rock composed chiefly of sodic plagioclase fespar, with mafic minerals such as biotite and hornblende granodiorite is intermediate between quartz diorite and granite. For convenience both granite and granodiorite are commonly grouped and referred as 'granite'.

8. Lamprophyre : Any group of igneous rocks characterized by a prophyrite texture in which abundant large crystals (phenocrysts) of dark coloured (mafic) minerals, biotite, amphibole pyroxene or olivine appear as a set in an aphinitic ground mass. They consists of low silica content and higher concentration of iron magnesium. Large portion of the matrix is composed of feldspars.

9. Lunar Basalts : Lunar basalts belong exclusively to the sub-alkaline class. They are similar to sub-alkaline basalts on earth. But have metallic iron rather than ferric iron bearing magnetite. Many lunar basalts are exceptionally rich in iron and titanium. They also differ compositionally from terrestrial basalts in being poor in alkali elements.

The meteoric basalts differ from lunar basalts and appear to have originated elsewhere in the solar system meteoritic basalts are called “Eucrites and Hoerdites”.

10. Obsidian : A volcanic glass of rhyolitic composition formed by rapid cooling of viscous lava. The colour is jet-black because the abundant microscopic embryonic crystal growth.

11. Pegmatite : Exceptionally coarse – grained and relatively light coloured crystalline rock composed chiefly of minerals found in ordinary igneous rocks may be sources of pegmatities are valuable sources of clays, felspares gem minerals micas, silica as well are beryllium, lithium, thorium and uranium.

12. Peridotite : A rock consisting of more than 90% of millimeter of centimeter – sizes crystals of olivine, pyroxene and hornblende other minerals mainly plagioclase, chromite, and gornet. Most of the volume of the mantle of earth is peridotite. It is rich in magnesium and iron in addition to nickel and chromium. It is the main ores of nickel and chromium. Other minerals are chromite, garnet. Most of the volume of the earth’s mantle is occupied by peridotite. They occur both as massive and layered structures. They occur near the base of gabbroid complexes.

13. Phenocryst : A relatively large crystal embedied in a finer grained or glassy igneous rock. The presence of phenocrysts gives the rock a porphyritic texture. Phenocrysts are represented by feldspar, quartz, biotite, pyroxene and olivine.

14. Phonolite : A light coloured, aphanitic rock of volcanic origin composed largely of alkali feldspar, felspathoids rapid cooling at the surface, causes lava to solidify with ever fine grained texture. Most of the features may be seen under petrological microscope.

15. Porphyry : An igneous rock characterized by porphyritic texture in which large crystal (phenocrysts) are enclosed in a matrix of very fine grained to a phanitic material.

Compositionally, porphrites range widely, but varities may be distinguished by prefixing to the term as granteporphyry, syenite porphory. These are gradational to plutonic rocks on one hand and to volcanic rocks on the other.

16. Rhyolite : A light-coloured aphnetic rock of volcanic origin composed largely of alkali feldspar and free silica with minor amounts of dark coloured minerals such as biotite.

Rhyolite is chemically equivalent to granite.

17. Trachyte : A light coloured a phanitic rock of volcanic origin composed largely of alkali feldspar with minor amounts of dark coloured minerals (biotite and hornblende) or pyroxene. If sodic plagioclase feldspar (oligolase and andesine) exceeds the quantities of alkali feldspar, the rock is called “Latite”. Thus “trachite and latite” are chemically equivalent to syenite and monozonite respectively.

18. Volcanic Tuff : Consolidate volcanic ash composed largely of fragments produced directly by volcanic eruption

much of the fragmental material represent finely comminuted crystals and rocks. Much was ejected as blobs of liquid lava which rapidly cooled to form volcanic glass.

19. Xenolith : A discrete rock fragment enclosed by magma lava igneous rock. The relation between xenolith and host magma may be closed or remote. It normally contains iron rich fragments.

B. Metamorphic Rocks :

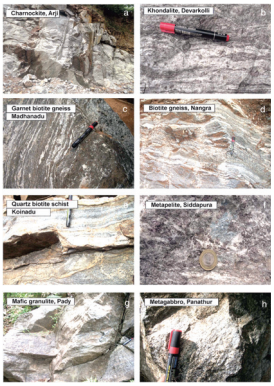
1. Amphibolite : A class of metamorphic rocks. Amphibolites are crystallines (recrystallized), foliated metamorphic rocks of greenish black colour composed of amphibole and plagioclase feldspar as essential minerals. Amphibolites are formed by regional metamorphism.

2. Eclogite : Eclogites are different from all other rocks consisting of pyroxenes or red-brown garnets. Hornblende also is present. Plagioclase feldspar is never found. Olivile, cynite, rvtile etc are found.

3. Epidiorite : It is an altered gabbro in which the plagioclase decomposes and is replaced by an aggregate of epidote and albite. Epidiorites have wide spread distribution among low metamorphic rocks and phyllites of mountain ranges in Scotland.

4. Hornfeels : A common name given to a metamorphic rocks produced by contact metamorphism. It is also known as hornstone. Hornfels are originally sedimentary rocks. As magma intrude the sediments, the heat given off induced re-crystallization and effected complete alteration of the primary sedimentary strata into hard, flinty rocks. Chemically this series are made up of silicon dioxide, (SiO_2), aluminium oxide, Al_2O_3 etc.

5. Khondolite and Charnockites Series : Charnockite may be considered as gneisses metamorphosed from crystalline rocks such as granites. This is also called ortho gneiss (primary) khondolite may be considered as the secondary gneiss metamorphosed from sedimentary rocks (para gneiss) secondary.



Both this are associated rock formations. Which pervade the areas of Nuzvid, Vijayawada, Mangalagiri etc.

6. Marble : A term applied commonly to any limestone or dolomite taking polish. Marble is extensively used for building and ornamental purposes. In petrography, the term marble is applied to metamorphic rocks composed of re crystallized calcite or dolomite. The schistosity is often controlled by the original bedding.

Regional metamorphic marbles are more or less deformed and therefore texturally marked by characteristic deformation patterns-parallel elongation etc.

7. Mica schist : A widely distributed group of rocks of medium to high grade metamorphism composed mainly mica and quartz and exhibiting foliated and schist are widely distributed in the pre-can brain areas and younger eroded mountain ranges where they are metamorphosed from aluminium rich sediments (clays and argillites).

8. Migmatite : Rocks originally defined as of hybrid character due to intimate mixing of older rocks (Schist and gneiss) with granitic magma. Now most plutonic rocks of mixed appearance are called as "migmatites".

Migmatites are found in zones of marginal to intrusive granite and in deep zones of ultra metamorphism.

9. Mylonte : A rock suffered extreme mechanical deformation and granulation but has remained chemically un altered. Quartz and feldspar are the chief minerals in the most common types of mylonites. A breccias structure may also be found.

10. Phyllite : A large group of regional metamorphic rocks derived from argillaceous sediments and re-crystallized in green shift facies (low degree of metamorphism). Essentially consists of white mica and quartz. Phyllites are fine grained and strongly schistose rocks with low metamorphism, phyllites pass into slates and with increasing metamorphism, they pass into mica-schist. Phyllite has distribution in crystalline mountain ranges of the world.

11. Quartzite : A metamorphic rock consisting largely or entirely of quartz. Most quartzite are formed by metamorphism of sandstone; but in some case metasomatic introduction of quartz SiO2 often accompanied by other elements-metals and sulphur. Pure sand stones yield pure quartzite.

12. Sandinite : A group of rocks formed by high-grade contact metamorphism (pro metamorphism) and pneumatolysis of certain sediments, mostly argillites. The original material was aluminium, mica shists with quartz, feldspar, kynite.

13. Serpentanite : An abundantly occurring, fine grained massive rock, generally derived from pneumatolytic or hydrothermal process from pre-existing basic or ultra-basic igneous intrusions. This inferred processes are called serpentanization.

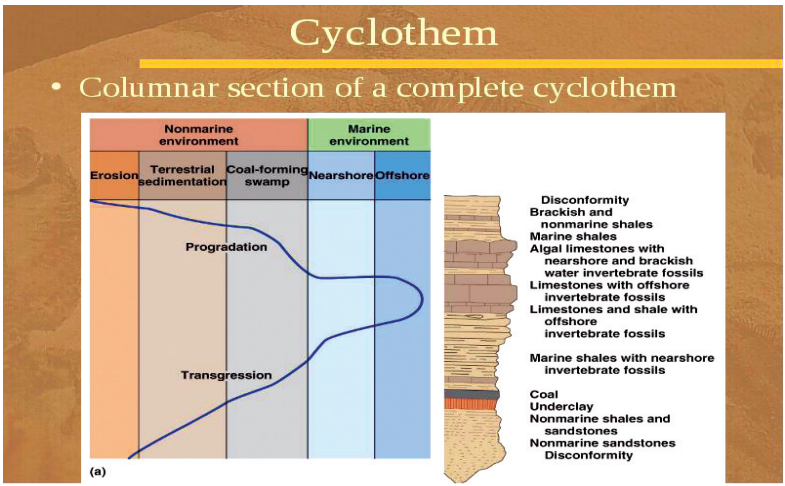
14. Slate : A group name for various fine grained rocks derived from mud stones, siltstones and other clayed sediments as a result of low degree regional metamorphism. Highly characteristic of slates is the perfect fissility or slaty cleavage which is a perfect planner schistocity and thus grading into phyllites the chief minerals are muscovite, chlorite and quartz. Slates are mainly used for roofing purpose.

C. Sedimentary Rocks

1. Black Shale : Shales which are soft, fine grained detrital sedimentary rocks may be divided into series of varieties based on colour. Black shales are very fissile all most papery and usually thinly laminated. Their dark colour is due to high content of carbonaceous organic matter. Most shales contain abundant sulphide sulphur.

2. Chert : A dense micro crystalline of crystalline of crypto crystalline rock composed of free silica, either in the form of chert is found in two forms as nodules in lime stone and dolomites and as bedded formations.

3. Cyclothem : A specific sequence of different kinds of rocks, one of which is generally coal. These sequence each on the order of about 10ft in thickness occur repeatedly the cyclothems have been recognized main in rocks of late Paleozoic in the eastern united states and also in coal bearing strata of rocky mountain region.



4. Dolomite Rock : The limestone whose carbonate fraction contains more than 50% of the minerals dolomite CA, Mg(Co3)2. To avoid the confusion between minerals and rock this dolomite rock may also be called as dolostone.

Dolostone rock exhibits the similar structure as limestone but finer details differ crystalline dolomites appear as to be secondary. The characteristic habit of dolomitic crystals growing in calcite matrix are rhombohedral.

It occurs in almost all rocks of ages known.

5. Graywacke : An argillaceous sandstone (dirty sand stone) characterized by and abundance of unstable mineral and rock fragments and a fine grained clay matrix binding the larger sand-size detrital fragments the unstable fragments include feldspar, augite, hornblende, biotite etc. The clay matrix is composed of a mixture of micaceous minerals. It is an ill sorted formation.

6. Lime Stone : A sedimentary rock composed dominantly of calcium and magnesium carbonate. Lime stones are the most abundant of the non-clastic rocks.

The chief minerals are calsite and aragonite and dolomite in dolomitic lime stone.

Siderite, the iron carbonate is found in some lime stones. The texture of limestone reveal much about their origin the chief textural elements are fossil whole or fragmental lime stones may be referred two types of origin.

a. Autochthonous b. Allochthonous

Autochthonous lime stones are formed in place by biogenic precipitation from the sea water in allo chthonous. Lime stones may be moved from the site of precipitation by current action the distances of transportation may be small it is just moving a chemical precipitation from one part of the sedimentary basin to the other.

7. Marine Sedimentary : The accumulation of minerals and organic remains on the sea floor marines sedimentary vary widely in composition and physical characteristics as a function of water depth. Variations in chemical or biological characteristics of their environments traditionally, marine sediments are sub divided on the basis of their depth of deposition into "littoral" (0-20 mts) neritic (20-200 mts) and bathyl (200-2000 mts) deposits. Coastal sediments include the deposits of deltas, lagoons, bays, beeches.

8. Oil Shale : A sedimentary rock containing solid, combustible organic matter in a mineral matrix. The organic matter often called as kerogen is largely insoluble in petroleum solvents, but decomposes to yield oil when heated.

Oil shale is lithified from lacusrine or marine sediments relatively rich in organic matter. Most sedimentary rocks contain organic matter, but the oil shales contain more organic matter.

9. Petroleum : A complex mixture of hydrocarbons (methane, ethane) containing small amounts of oxygen,

nitrogen and sulphur compounds. Accumulation involves three steps :

a. Generation of oil

b. Primary migration : Movement of oil from source to reservoir rock.

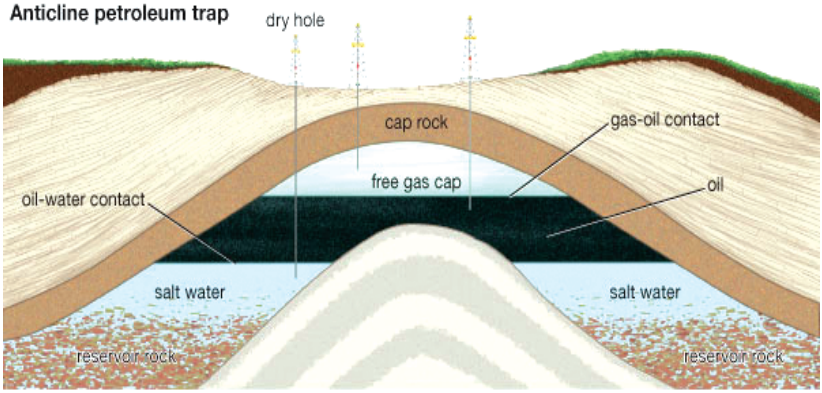
c. Secondary migration : The redistribution of oil with in the reservoir rock to form a pool.

Generation of oil : 10% of oil is generated from decay of hydrocarbons of decayed marine organisms as part of living cells. 90% of oil is generated from decay matter. In case of migration process water plays important role. Beyond 2000mts, hydrocarbons continue to increase.

Petroleum geology deals with the geological structures as containers without origin and migration. Along continental shelves, most of the oil fields occur. In most of the cases anticlines are the favourable structures for oil accumulation.

Geological features that influence the accumulation of petroleum includes salt domes, anti cllinally folded strata and combinations of folding and faulting. Reservoir rocks may be classified as fragmental or clastic (broken), chemical or bio-chemical. The reservoir traps contain the accumulated oil or gas so that it cannot escape the upper boundary of the reservoir trap is closed. The cap rock which is an impermeable layer the anti clinal theory is a successful theory of petroleum geology most of the oil fields of the world occurs in anti clines as recognized by W.E.Login in 1842 near St. Lawrence river Anti clinal theory has been safe guarded from criticism based on the fact that oil or

gas tend to accumulate at the highest places in the reservoir rocks which is an observed fact in the most cases.



10. Red Beds : Detrital sedimentary rocks pigmented by ferric oxide that coats grains fills pores as cement or depressed in a muddy matrix. These conspicuously coloured rocks constitute thick sequence of non marine to shallow marine deposits detrital red beds accumulated in many parts of the world. The development of red pigment in these beds is not clearly known. In general ferric iron imparts red colour, but this is not found in red beds.

11. Regolith : The mantle rock a blanket of unconsolidated rocky debries of any thickness that overlies bed rock. Undisturbed regolith may grade from agricultural soils at the surface through fresher and coarser products of rock weathering. Elsewhere bed rocks may be covered by transported material. Such transported regolith may bear no relation to bed rock on which it rests.

12. Sand Stone : The most informative variety of sedimentary rocks is the sand stone with respect to depositional environment, origin which paves the way for critical discussions. There are three type of sand stone terriginous, carbonate and pyroclastic.

Terriginous clasts are derived from the pre-existing rock outside depositional basin. They are transported by moving current of wind and water. Carbonate sand stone mainly consists of calcium carbonate in the form of skeletal debris. Most carbonate sand stones are deposited in marine environment. Pyroclastic sand stones are composed of rock fragments which were directly by explosive volcanic activity. These are volumetrically the least important sand stone and it is of the theoretical importance the mineral contents are quartz, feldspar and rock fragments. The sand stone occupy the total volume of 10 to 20% sedimentary basins of earth's crust.

13. Sapphire : The name given to all gem varieties of the mineral corundum. The lovely orange variety of gem corundum is known by the exotic name padaparadsha and as orange sapphire has a hardness of 9. (It is a variety of corundum.)

14. Stylolite : Stylolites are irregular surfaces mostly parallel to bedding planes. Stylolites are most common in lime stones and dolomites and also present in many kinds of rocks including sand stones.

Stylolites cut across many structures in the rocks they traverse including fossils and oolites. Commonly these structures show truncation or partial solution. The most probable origin for stylolites is pressure solution in an already lithified rock.

15. Silt Stone (Argillaceous rocks) : The Argillaceous rocks (lutites) include shales, argilites, silt stones and mud stones. They are constituent particles are less than 1/10mm (if silt stones are included) and less than 1/256mm (if silt stones are excluded). They are the most abundant sedimentary rock type, varying according to different estimates from 44 to 56% of the total sedimentary rock column.

VII. MINERALS :

Naturally occuring substances with a characteristic chemical formula and composition. They may occur as individual crystals or may be disseminated in some other mineral or rock. Most of them occur in rocks of earth's surface.

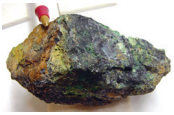
A natural occurring substance with a characteristic chemical composition expressed by a chemical formula. Coal and oils are also naturally occurring substances, but they are not listed under minerals due to complex mixtures of other substances they are not listed under minerals.

1. Anhydrite : A mineral with chemical compostion of $CaSO_4$ and occur as white and grayish masses and in orthorhombic crystals.

2. Apatite : The most abundant widespread of the phosphate minerals and crystallizes in hexagonal system.

3. Aragonite : A mineral species of calcium carbonate.

4. Argentite : It is a mineral having composition of (Ag_2S) (sulphur of silver).



5. Argyrodite : A mineral having composition of Ag_8GeS_6.

6. Arsenopyrite : A mineral having composition of (FeAcs). Arsenopyrite crystallizes in monoclinic system.

7. Arsenolite : A mineral having composition of As_2O_3 and crystallizes in isometric system.

8. Asphalt : Naturally occurring bituminous minerals. It is also produced as a petroleum byproduct. They occur as viscus impregnation in sand stones. Both substances are black and are soluble in carbon disulphide.

9. Augite : A group of monoclinic pyroxene which has the general chemical formula (Ca, Mg, Fe) (Mg, Fe) Si_2O_6 augite occurs both in metamorphic and igneous rocks.

10. Azurite : A basic carbonate of copper with the chemical formula $Cu_3(OH_2)(CO_3)_2$. It is associated with copper minerals such as malachite. It crystallizes in monoclinic. It is used in pigments.

11. Barites : A mineral with chemical composition of barium sulphate $BaSO_4$ and occurs in white and yellow or thorombic crystals. It is used in well drilling mud and also as weight concrete around pipes in river crossings.

12. Bauxite : It is the ore of aluminium. It contains aluminium oxides and aluminium laterites. It is commonly pisolitic and concretionary.

13. Beryl : A aluminium berylo silicate mineral $Al_2(Be_3Si_6O_{18})$ and crystallise in hexagonal system hardness is 8.

14. Biotite, Muscocuite, and Phlogopite : A micaceous minerals which is the black variety and muscovite are white mica, and are having commercial value. Micas are having perfect cleavage. Muscovite occurs in pegmatites. They also occur in younger metamorphic and sedimentary rocks.

15. Borax : A hydrated borate mineral with chemical composition of $Na_2B_4O_5(OH)_4.8H_2O$. It is not uncommon in monoclinic prismatci crystals. It is also found as massive occurrences.

16. Bronzite : One of the ortho-rhombic series with chemical formula (FeSi 10 to 30) where as FeSi is ferro silicate nodules.

17. Brucite : A magnesium hydroxide mineral $Mg(OH)_2$ crystallise in trigonal system.

18. Calcarnite : A mechanically deformed limestone in which the constituent particles of carbonate are of sand grain size.

19. Calcite : One of the most common and wide spread minerals in the earth's crust. ($CaCO_3$). It is also important mineral of calcite marbles, carbonates and pure lime stones. It is used as metallurgical flux.

20. Celestite : A mineral of (strontium sulphate) and crystallizes in orthorhombic system. Fracture is uneven and luster is vitreous.

21. Cerrucite : The mineral form of lead carbonate ($PbCO_3$) and is having orthorhombic symmetry.

22. Chalcopyrite : A major ore mineral of copper with composition ($CuFeS_2$) and crystallizes in tetragonal system.

23. Chalcosite : A mineral having composition of copper sulphate and crystallizes in orthorhombic system.

24. Chalk : A variety of lime stone formed from floating organisms of fine grained and porus in nature. The rock is made up of calcite shells of micro organisms.

25. Chalsdony : Fine grained fibrus variety of quartz silicon dioxide.

26. Chlorite : A group of hydrus silicates which are closely related to micas. They are normally green containing ferrous iron.

27. Chromite : A mineral of chromium and crystalline in isometric system.

28. Chryso beryl : A mineral having composition of iron, alluminium $BeAl_2O_4$ as crystallizes in pseudohexagonal.

29. Cinnabar : A mineral of mercury having composition of HgS. And crystallize in the hexagonal system. It occurs in fine granular and massive forms.

30. Commingtonite : The name given to calcium poor monoclinic amphiboles rich in iron and magnesium.

31. Cordiarite : an orthorhombic magnesium, alluminium silicate Mg2( ). The crystal structure is related to beryl. It occurs in metamorphic rocks.

32. Corrundum : A mineral with the ideal composition of Al_2O_3. It is one of the largest group of isostructural compounds including haematite (F_2O_3), and it crystallizes in hexagonal system. It occurs both in metamorphic and igneous rocks as rock mineral. H = 9

33. Coverlite : A mineral having composition Cu5 and crystallizes in hexagonal system. It is having perfect basal cleavage yielding flexible plates.

34. Cuprite : A mineral having composition of Cu_2O and crystallizes in isometric system. It is one of the main copper ores.

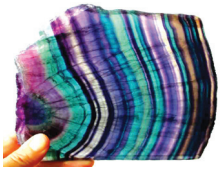
35. Diamond : A mineral composed of carbon crystalised in the isometric system. It is too hard and used for cutting and abrading hard stones. It is also used a gem stone in ornament. This may be considered as the allotropic form of carbon. H = 10

36. Diopside : A monoclinic pyroxene mineral of calcium and magnesium silicate. Pure diapside melts congrountly.

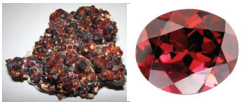
37. Dolomite : The carbonate mineral with composition of $CaMg(CO_3)_2$ and crystallizes in hexagonal system. Dolomite occur in almost all formations of all ages. It occurs in a variety of geological settings.

38. Drumlin : A hill of glacial drift or bed rock having half ellipsoidal stream-line form like inverted bowl.

39. Epidote : A group of minerals having monoclinic symmetry and the ideal compsition $Ca_2FeAl_2O_3(OH)(S_2O_3)(SiO_4)$



40. Flourite : A mineral composed of CaF_2. It is the most abundant fluorine bearing minerals with purple colour. It occurs as cubes and veins of lineage features.



41. Garnet : A generic term applied to group of minerals of silicates that are of isometric system in crystallization of individual mineral species in Mg, Al, Fe, Ca, Silicates.

42. Galena : A mineral with chemical composition of PdS. And belonging to the rock salt. It commonly occurs as cubes and it is important ore for lead.

43. Garnearite : A mineral used as a minor ore of nickel. It is a monoclinic serpentine.

44. Gemstone : A mineral is defined as an inorganic substance with a characteristic chemical composition and usually as characteristic crystal structure. Each mineral as species by the gemotologist most gemstones are crystalline and are having characterized properties. Lustre, cleavage and durability.

Gemstones : Topaz, corundum, beryl etc.,

45. Gold : This chemical element occurs as a mineral with isometric symmetry when exhibiting crystal form gold is octahedral. Gold is malleable and ductile. The vein type deposits consists mainly of quartz with pirite and other sulphide and variable concentrations of gold. The placer deposits consists of sands and gravels between which fine particles or larger nuggets of gold are concentrated. Such gold particles may also occur in conglonerates of recent origin. Gold also occur in blue quartz as veins.

46. Graphite : A low pressure polymorph of carbon, the common high pressure polymer is diamond. Graphite crystallize in hexagonal system. The mineral is very soft it soils the hand fingers. It leaves black streak on paper hence it is used in manufacture of pencil etc. Graphite arises from the thermal and regional metamorphism of rocks such as sand stones, shales, coals and lime stones which contained organic products. Carbon in granite has got both metallic and non-metallic properties.

47. Gypsum : A mineral with the chemical composition of $CaSO_4H_2O$ and is the commonest of sulphate minerals and crystallized in monoclinic system.

48. Hematite : The most important ore of iron with composition of Fe2O3 crystallizing in rhombohedral system. The colours is usually gray and blood red.

49. Halite : A mineral with chemical composition of NaCl. Stratified in sedimentary rocks of marine origin.

50. Halite : A mineral having chemical composition of NaCl sylvite has the similar composition KCl. (potassium chloride) in structure and occurrence.

51. Halloygite : A group of clay minerals made up of the same structure units as kayolinite. The major use of these mineral is in the manufacture of cracking petroleum catalysts.

52. Havlandit : A mineral belonging to the zeolite family of silicates and crystallizing in monoclinic system which usually occurs with prominent side pinacoide having often

diamond shape. This is essencially hydros calcium and silica.

53. Hornblende : A general name given to monoclinic calcium amphiboles. It occurs widely in igneous, metamorphic and volcanic rocks.

54. Humite : A series of magnesium, nesosilicates mainly closely related to crystal structure and chemical composition. It crystallizes in orthorhombic system.

55. Humus : The amorphous dark coloured colloidal matter in soil representing complex of the frictions of organic matter of plants and animals etc.

56. Jade : The name is applied to two distinct minerals the two jades are jadeite and nephrite. Nephrite is one of the amphibole group of rock forming minerals it occurs along with the combination of minerals tremolite and actinolite.

57. Jadiete : The name given to monoclinic sodium aluminium pyroxene (NaA_2SiO_3) jadeite forms grey coloured fibrous crystals which are colourless in sections.

58. Jasper : An opaque impure massive fine grained quartz that typically as a tile red dark brownish red and brown. Both jade and jasper are used as gem stones.

59. Kynite : A neso silicate mineral with composition of Al_2SiO_5 crystallising in triclinic system. This is one of the polymorphic alluminium silicate Al_2SiO_5.

60. Kyolinite : It is the principal member of clay minerals. It is composed of single silica tetrahedral sheet and a single

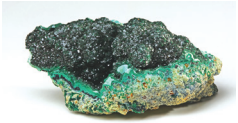
aluminia octahedral sheet. It is important in ceramic industry.

61. Lepidilite : It is a mineral with variable composition of lithium mica and lithoxinate rubidium and cesium may replace potassium. It is an uncommon mineral occurring in granitic pegmatities.

62. Lignite : Soft and porous carbonaceous material intermediate between peat and sub-bitiminous coal. Lignites are also called as "bown coals".

63. Magnatite : A cubic mineral and member of spinal structure group. It contains both ferric and ferrous iron.

64. Magnesite : It is the mineral form of magnesium carbonate $MgCO_3$ and crystallise in hexagonal system.



65. Malachite : A basic carbonate of copper with the chemical formula $Cu_2(OH_2)(CO_3)_2$. It is naturally associated with copper ore deposits. It mostly occur in massive from crystallizes in monoclinic system.

66. Manganite : A manganese mineral having composition MnO(OH) crystallizing in orthorhombic system in prismatic crystals.

67. Metamict : The amorphous state of substance that has lost its original crystalline structure because of the radioactivity of uranium and thorium.

68. Native Elements : Those elements that occur in nature un-combined with other e.g.: Gold, silver, platinum, copper etc.

69. Onyx : The name onyx is applied to banded chalcedonic quartz in which bands are straight and parallel usually, the natural colours are red and brown.

70. Oolites and Pisolites : They are small more or less spherical particles commonly found in lime stone and dolomites.

71. Opal : A natural hydrated form of silica. These are used in gem stones.

72. Orthoclase Feldspar : A name for potassium feldspar widely contain sodium feldspar albite to anorthite. Perthite and antimollinite. Crystallise in monoclinic system.

73. Peat : A type of humas. A dark brown or black residue produced by partially decomposition and disintegration of mosses, sedges, trees and other plants that grow in marshes. Peat may accumulate in depressions such as the coastal and tidal swamps.

74. Pitchblende : The principle uranium minerals from the point of economic importance are the oxide uraninite and its variety pitchblende.

75. Plagioclase Feldspar : Plagioclitis feldspar form at high temperature of solid solution. Anorthoclase, oligoclase andesine and albite.

76. Pyrargirite : Silver having composition of $Ag_3S_3S_3$ and crystallization in hexagonal system. Crystals are prismatic.

77. Pyrite : A mineral having composition of FeS_2 and crystallize in isometric system. It may be massive or granular. It is the mineral of iron.

78. Pyrolusite : Important ore of manganese (MnO_2) and crystallizes in tetragonal system and occur as radiating fibers.

79. Siderite : A mineral form of ferrous carbonate often containing magnesium and manganese.

80. Siliminite : A neso silicate mineral with composition (Al_2SiO_5) alluminium silicate and crystallizes in orthorhombic system. Siliminite, and kynite and andalisite are the polymorphic form of (Al_2SiO_3) they are found in metamorphic gneisses and schists.

81. Smithsonite : A mineral form zinc carbonate. It may contain small amounts of iron and calcium. It crystallizes in hexagonal system.

82. Sodalite : A mineral of the tecto-silicates of feldsphathoid group crystallizing in isoclinic system.

83. Sodanitre : A nitrate mineral having chemical composition $NaNO_3$. It crystallizes in rhombohedral division.

84. Talc : A hydrated magnesium silicate. The structure is closely related to micas small amounts of Al_2O_3 may enter into talc. Structure as impurity.

85. Tetrahedrite : A mineral with composition of copper, iron, silver, zinc and crystallites in isometric system. It is generally formed in contact metamorphic deposits.

86. Till : It is un stratified portion of glacial drift. The unsorted materials are deposited by the advancing ice.

87. Tin : Minerals Titanium, Cassiterite, thorium and topaz are the minerals of tin.

88. Topoz : It is a well known gem stone. Crystal are colourless but may be red, yellow or green in some cases. It is a monosilica with the chemical composition of aluminium silicate and ferri oxide. It is usually occur in pegmatitic dykes.

89. Tourmaline : A mineral cyclo silicate with complex chemical composition and crystallize in hexagonal system. It is one of the important gem stones.

90. Travertine : A radhar dense banded lime stone sometimes moderately porous that is formed either by evaporation about springs as in caves as stalactites or drip stones. This sort of deposition occurs when there is loss of carbon dioxide.

91. Tremulite : The name given to magnesium rich in monoclinic calcium amphibole.

82. Uraninite : The chief mineral of uranium. Thorium and rare earth's are also present as the products of radioactive decay. Uraninite crystallizes in isometric system.

93. Vermiculite : A clay mineral of clay materials constituents. It resembles monti morillinite.

94. Wavallite : A hydrated phosphate of alluminium mineral with composition $Al_2(OH)_5(PO_4).5H_2O$ and alluminium respectively it crystallizes in orthorhombic system.

95. Witherite : The mineral from of uranium carbonate and crystallize in orthorhombic system. It may be formed in association with barite and galena.

96. Wolframite : A mineral with composition of (Fc, Mm)WO_4 intermediate between ferborite. The iron tungastate and manganese tungastate. It is mainly tungsten mineral.

97. Wollastanite : A mineral with composition of ino silicate $CaSiO_3$. It crystallize in triclinic system.

98. Wulfenite : It is the mineral consisting of lead molybdate $PdMo_4$ and crystalline in tetragonal system.

99. Wurzlite : The mineral with composition of zinc sulphate (ZnS) and crystallizes in hexagonal system.

100. Zeolite : A mineral belonging to the zeolite family minerals and synthetic compounds characterized by alluminium silicate in tetrahydral frame work.

101. Zincite : A mineral with composition of ZnO (Zinc Oxide) and crystallizes in hexagonal system.

102. Zircon : A minerals with the idealized composition of $ZnSiO_4$ (zircon silicate) and is the important ore of zirconium. The name cryolite may be applied to an altered type of zircon. It crystallizes in tetragonal system.

VIII. IMPORTANT ITEMS OF ALL BRANCHES OF GEOLOGY :

1. Actualism : Actualism accepts the basic premise of uniformitarianism, that physical and chemical laws are constant over geological time but the purpose that rate and intensity of the resulting processes may vary.

2. Affective Factors – Types of Soils – Erosion : The rate and extent of soil erosion depend upon such interrelated factors as type of soil, steepness of slope, climatic characteristics and land use.

i. Type of soil : Soil types vary greatly in physical and chemical composition the amounts of sand, silt, and clay constituents, colloidal material and organic matter all have bearing upon the ease with which particle or aggregates are detached from the body of the soil.

ii. Slope : The relation of the slope to the amount of erosion on different classes of soil is of paramount importance. The amount of erosion increases greatly with increase in the slope of land.

iii. Climate : In cold climate, the erosion of soil is not subject to erosion for several months of the year. As the water moves over a thin unfrozen layers of soil, it transport much of the soil material down grade.

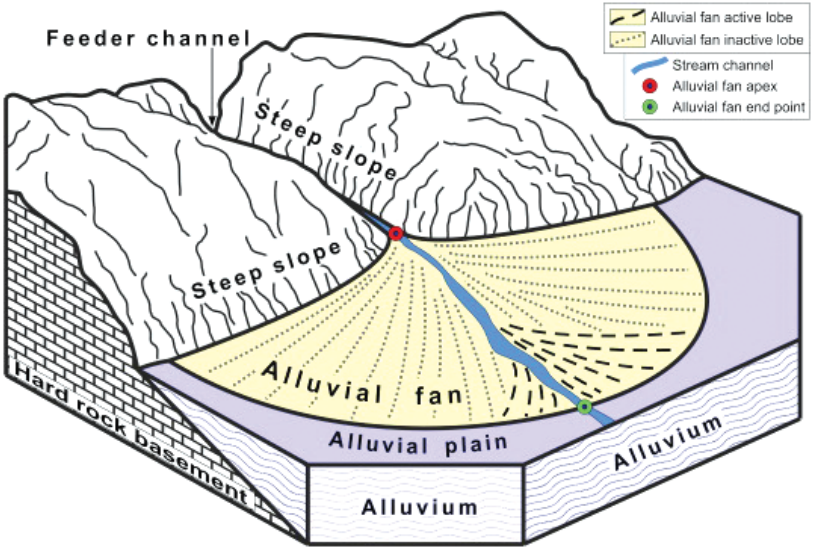
Amount of rainfall has greater bearing on soil

erosion. In case of dry climates, soil erosion is much effective in sandy areas.

iv. Land Use : The type of crop and system of management influence the amount and type of erosion. Grassy areas resist erosion.

3. Alluvial Fans and Cones : Alluvium is the deposit formed by stream and is potential for ground water development. Analogous to deltas, alluvial fans are formed when a heavily loaded stream change gradient with resulting deposition of alluvium apexing at the point of emergence and spreading out into the lowland.

If the slope of the surface is steep it may be called as alluvial cone. Fanglomerates from fan deposits and congilomerates from cone deposits are resulted.



4. Aquiclude : A geologic formation although porous and contain water which cannot be transmitted because of the smaller of the pore spaces causing high resistance. Ex: Clay lenses, shale etc.

5. Aquifer : A geologic formation containing water in its voids and which yields significant quantities of water. The void spaces must be wider enough for the movement of water. Ex: Sand stone, gravel.

6. Aquifer Confined : It is completely saturated aquifer whose upper and lower boundaries are impervious layers the pressure of the water is higher than that of the atmosphere. The water in a confined aquifer may be called as "Artesion" confined water.

7. Aquitard : A geological formation which transmits water at slower rate when compared to an aquifer clay beds inter bedded with silt and clay.

8. Asbestos : It is the general name of fibrous varieties of six rock forming minerals. The value of asbestos derived from the strength as a reinforcing agents, its relative chemical inertness, and the incombustible nature. Over 95% of production of fibrous serpentine.

The term asbestos include only the fibrous form of one serpentine group and five amphiboles group minerals. Asbestos or fibrous amphiboles are more generally heat and acid resistant than serpentine variety.

It is mainly used in brake linings, heavy packing and gaskets, Electrically insulating materials. It is also used to make shingles, sheetsiding, pipefloor tiles, paperbinders for other heat insulators.

9. Atmosphere Evolution : The atmosphere is a most tenuous envelope its mass is less than one million of the solid earth, today the atmosphere contains small number of major components and a very large number of minor components. Each component exerts pressure which is essentially constant for some components at sea level and which is variable in time and space for other components. At present for instance, gases like ammonia (NH_3), Methane (CH_4), and hydrogen (H) can exist in the atmosphere as trace components only, because they are unstable in presence of oxygen is abundance conversely could not have been a major component of atmosphere in which ammonia, methane and hydrogen were abundant.

Thus the free oxygen is anomalous on the earth. Rocks also are oxidized when they are in contact with the atmosphere. The effect of photo synthesis is pronounced on the existence of free oxygen. In the atmosphere of the atmospheric constituents other than oxygen, there are gases, nitrogen, and carbon dioxide are most important.

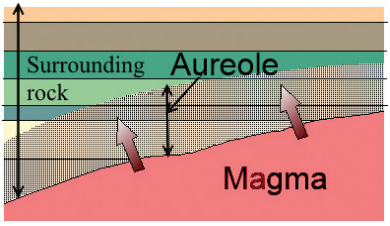
10. Atoll : An angular coral reef, with or without small inlets that surrounds a lagoon without projecting land area.

Most atolls are isolated reefs rising from the deep sea level and vary considerable in size. Small rings without islets may be less than a mile in diameter, but many atoll have a diameter have 20m and bear numerous islets. The largest islet, Kwajalein in the Marshall islets has an irregular shape and cover $540m^2$.

The reefs of the atoll ring are flat pavement like areas, large parts of which are particularly along the seaward margin may be exposed at times of low tide. The

reefs vary in width from narrow ribbon to broad building areas more than a mile across. Usually brownish and pinkish in colour. This ridge is composed of calcareous algae.

11. Aureole : A hollow or zone of alteration surrounded by igneous rock (granite or granodirite) and presumably formed by heat and emanations from the igneous mass. Aureoles are most more than 2000ft. The aureoles are easily detected based on mineralogical and textural change in the surrounding country rock. The aureole thus represent a shell of changed or metamorphosed rock. Shale and lime stone are conspicuous than the sand stone.



In the outer part of the aureole recrystallization may be highly sporadic and restricted to certain minerals only. Reconstitution in the outer part of the aureole may be indicated by the presence of small pots or knot like aggregates of new minerals. Well within the aureole where re-crystallization and neo-mineralization are pronounced, old structures (bedding and shistocity) may be obliterated.

12. Bed Rock Topography : On weathering and erosion, many geological formations develop land forms which are distinctive in respect of slope and continuity out crops symmetry of valley flanks. The surface features of the bed rock can be extrapolated to reasonable depths to predict the thickness of alluvium and aelian sands. Most natural stream profiles are characterized by up concavity and a persistant down stream decreasing gradients. The knowledge of these aspects relating to changes in stream profile is useful for the assessment of thickness of valley files. The bed rock topography has got influence on the water table of aquiferous zones.

13. Bedding : A layering of sedimentary rocks resulting from the original process of deposition bedding is commonly used as synonyms for stratification. But in bedding in which the layers (strata) are thicker than 1cm it is called lamination, if is less than 1cm. Bedding generally results from combination of two main factors.

i. Factors acting during original deposition (mechanical arrangement)

ii. Consolidation and chemical alterations after deposition.

a. Graded Bedding : The deposited bed of sand tend to show a progressive grading with the coarsest sediment near the base and finest at the top.

b. Cross Bedding : The sudden changes in the rate of sedimentation lead to cross bedding.

14. Bentonite : The term first applied to a particular highly colloidal plastic clay that was found near Benton in the

cretaceous beds Wyoming. The clay swells several times its original volume when placed in water forming as gel. Bentonites are of commercial value. They are used in decolorizing oils, in bonding moulding sand, in the preparation of oil well drilling muds. Based on its origin of its type, it is used specifically for specific purpose the bentonitic clay from Wyoming is quite suitable to be used as drilling mud.

15. Bowen's Reaction Series : Crystallising under equilibrium conditions, early magmatic minerals react with remaining fluid to yield liquid fractions richer in silicon dioxide, alkalies, iron and water than the original magma and crystalline fractions richer in calcium and magnesium than the parent magma (magmatic differentiation).

Discontinuous reaction series	Continuous reaction
Olivine	Calciplagioclase
Enstetie	
Hypersthene	
Augite	
Amphiboles	
Biotite	sodic plagioclase

(See the illustration in the end.)

16. Breccia : A rock composed for fragments similar to a conglomerate in distribution of the sizes of the materials. Breccias differ from conglomerates in the sharp angular nature of the fragments. The sedimentary breccias are to be distinguished from volcanic materials. Tectonic breccias formed by fracturing and disruption due to faulting. Breccias derived from erosion of cliffs or scraps with little or no transportation are called talus breccias or scree.

17. Catastrophism : The geological doctrine attributes all major features of the earth's crust. Such as folds, and faults as well as the lateral and vertical succession of rocks exposed in a particular region and the dramatic secular changes in fossil flora, fauna to sudden somewhat repetitions, short lived, violent and essentially global events is "catastrophes". Catestrophic events occurred as are result of forces which were beyond human understanding and were therefore considered to be un-natural and mysterious.

18. Cirque : A deep steep – walled recess roughly semi-circular in plan cutting the bed rock of a mountain or other highland. It has the form of half a bowl and results from erosion beneath or around snow bank or glacier. Many cirques occur at the heads of valleys.

19. Classification of Environments of Sedimentation – by W.H.Twenthofel:

A. Continental environments

i. Terrestrial – desert

Glacial

ii. Aqueous fluvial – Piedmont

Valley flat

iii. Paludal : lake swamps, river swamps, flat land swamps, paralic swamps.

iv. Laccus straine : Fresh, salt (lake)

B. Mixed continental and marine ( ) littorak, delta, marginal lagoon estury.

C. Marine environments : Neritic – 20mt depth

Bethyl – 200 to 2000mts depth

Abyssal – below 200mts depth

20. Classification of Soils : System of soil classification are influenced by concepts, prevalent at the time of system is developed. Soil has been considered as the natural medium for plant growth. Under this concept, classifications were based on relative suitability for different crops, such as rice soil, wheat soils and vinegard soils. American classification was based on the nature of underlying rock. The Russian students developed the concept of soil as independent natural bodies formed by the influence of environments operation on parent. The early Russian classification is based on climate and

vegetation they had classes of normal, abnormal, and transitional which later become known as zonal, intrazonal and azonal. Within the normal or zonal soils, the Russians distinguished climate and vegetative zones in which the soils have distinct color and other properties in common. According to this concept, soil may be categorized as gray forest soils and gray desert soils.

21. Cleavage Rock : A secondary foliation produced by deformation such surfaces usually exist as planes of weakness along which a rock may split. Rock cleavage is mainly associated with either folding or faulting.

22. Coastal Land Forms : The characteristic features and patterns of land in a coastal zone subject to marine and sub aerial processes of erosion and deposition. Coast land lives between the shore line or mean low water line and includes many features of relief and other features of shore line topography. The attack of the sea has been concentrated at or near the present level only for some 5000 to 60,000 years. During the preceding 130 centuries are so the sea level rose some 400ft. as a result of an increase in ocean volume by melt waters from the warming continental ice in the pleistocine. Coastal land forms which originated during low stands of the sea now lie submerged off shore.

A. Constructional Land Forms : These are included among the forms are deltas, deltaic costal planes beaches, bars, spits, reefs, duns and many minor features. Along the coast of warm seas algae, coral and other organisms may accumulate.

Deltas grow seaword in estuaries and at rivers mouths. They may extend outward into sea where rivers deposit their loads more rapidly than land subsides or currents carry sediments away. The location of delta depends on the topography of the main land.

B. Destructional Land Forms : Erosional land forms includes sea cliffs, wave cut benches, arches and caves near sea level erosional forms depend to a large extent upon the type of coast under attack.

i. Fiord Coast : A bedrock region that is deeply scored by the glaciers may become fiord coast. Along such coast deep asteries may extent far inland as in southern Alaska and Chilli.

ii. Ria Coast : These are characterized by irregular coastal indentations similar to fired coast.

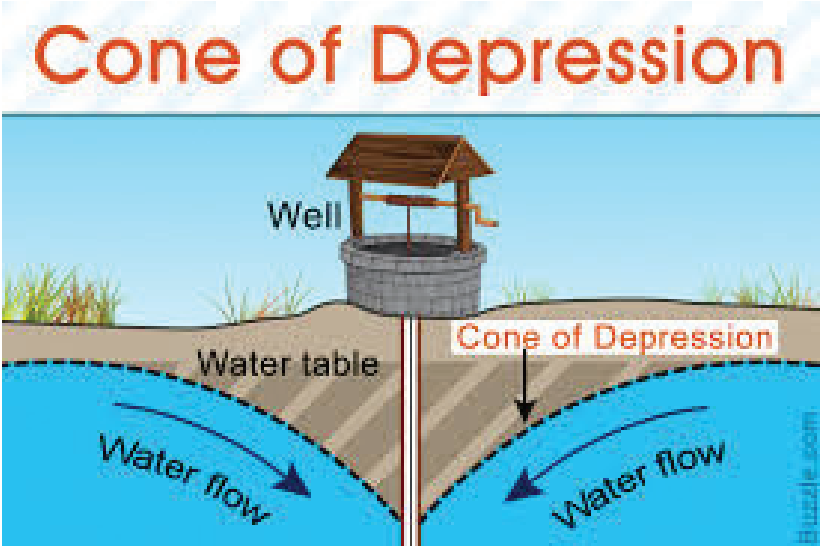
iii. Karst Coast : Karstic features are produced in a strata of relatively soluble lime stone along some coast such as the dalmaian coast of the Adriatic.

C. Emergent and Submergent Shore Lines : Smooth cores were regarded based on the hypothesis that sea bottoms or flats more complicated floor lines were regarded as submergent because of the lowering of the land.

D. Uplift of land forms occurs rapidly along many cores particularly those with mountains shores thus beaches, sea cliffs, costal flats and other land forms are elevated well above the sea level.

Eg: Smooth coasts of New Jersey (America)

23. Cone of Depression – Spacing : During the pumpage of the water from the well, the water level exhibits a conical depression extending water level laterally. This is called "cone of depression". If there is well nearby in the vicinity, the declining water level, it will interfere with the water level of such well causing lesser yields and in some cases they may lead to failures hence, the farmers must follow the stipulated spacing norms to save the yield of the wells avoiding such interference effects.



24. Conglomerate : The consolidated equivalent of gravel. They are the aggregates of more or less rounded particles greater than 2mm in diameter frequently they are subdividing on the basis of size of particles into pebbles (fine), cobble (medium) and boulder conglomerates (coarse).

25. Conjunctive Use of Surface and Ground Waters : Normally, farmers are not using ground water when there is canal water but it is not safe for the soils. As there is every possibility for the logging condition rendering the soils saline because of water sagnation. Hence it is better to implement the scheme of conjunctive use (simultaneous use of surface water and ground water). In this way we can protect the soils avoiding stagnation on one side and artificial recharge from the canal network may be accomplished and more area may be brought under irrigation.

26. Connate Water and Juvenile Water : Some ground water may originate by chemical and physical processes that takes place deep within the earth. Such water is called "Juvenile water or Primary water" to indicate that it is reaching the earth's surface for the first time. The available evidence indicates such water is highly mineralized. Some water is stored in deep – lying sedimentary rocks and is a relic of ancient seas in which these rocks were deposited. It is called connate water.

The total quantity of water from juvenile and connate sources that enters the hydrologic cycle is in significant when compared with the quantities of water from precipitation (meteoric water).

It is balanced to some extent by withdrawal of water from the hydrologic cycle by such process as deposition of minerals that include water in their crystalline structure.

27. Continent Formation : The continents are more or less accurately began to form in the final stage of the origin

of earth because of the speculative views of earth's origin. The initial stages of continents remain enigmatic. It is known that the earth accepted from cloud and chunks of the solar matter about 4.6x10^9 years ago.

Accretion of both earth and moon may well have occurred as the solar plasma and gasses cooler and precipitated and accreted first in this scenario 10, the higher temperature, more refractory elements that compose that earth's core and mantle would have precipitated and accreted first followed seruentially by successfully lower temperateure silicates, oxides and other substances.

28. Continental Drift and Sea Floor Spreading : The parallel Atlantic boarders of the America and Africa first led scientists to speculate that these continents were originally single unit which was split apart by drifting. Alfred Wegener first popularized the idea in 1910. Through this century, the theory has becomes the subject for much debate.

Convection cells : A concept of continental drift by spreading of the sea floor has attracted much attention. An important part of this sea floor spreading hypothesis is that the heat generated in the earth causes convective overturn of mantle material in a number of convection cells. The mid-ocean ridges are thought to lie along the juncture of the upwelling limbs of separate cells. At the surface the upwelling material diverges and flows away from the ridge axes, carrying the continental blocks along with it until they come to rest over or nearer down flowing convergence. It is suggested that the reversal of the magnetic field produce areas of reversely magnetized

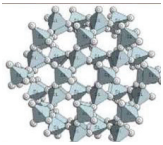
crustal rock, symmetrical with respect to the ridge axis. The times of reversals are known for the last 5000,000 years and on the basis of this hypothesis values of 1-4cm/year have been deduced for spreading rates. The descending flow is thought to create the deep sea trenches and earthquake fault planes mentioned and resulting compression to be responsible for mountain building and volcanism associated with trenches.

The position of mid-ocean ridges, rock magnetism and sedimentation acclaimed evidences are cited in support of sea floor spreading.

29. Coral Reef : A mass of ridge of a rock or rock forming organisms in a water body, rocky trend in a soil. Naturally cemented sand ridges make reefs along the coasts.

Coral reefs are the biogenic reefs wide spread volumetrically consisting of coral and associate calcium carbonate – secreting organisms. Coral reefs are exclusively marine and the typical reef building type are restricted to shallow warm water because of their symbiotic association with microscopic algae. A toll is an annular coral reef that surrounds a lagoon without projecting land area. Most atolls isolated reefs rising from the deep sea most atolls.

30. Crystallography : The branch of science that deals with the geometric description of crystals their internal arrangement and their



properties as a part of mineralogy crystallography is now a vast Naman's land between physics, chemistry, mineralogy and even biology.

31. Deep Sea Trenches : Deep sea trenches are important structural features associated with some continental margins, Island arcs, earthquake belts and areas of volcanic activity. Most of them are confined to the margins of pacific ocean. The deepest trench in the pacific being about 10.7km in the Mariana's trench and the deepest in the atlantic 8.4km in the Purtorico trench.

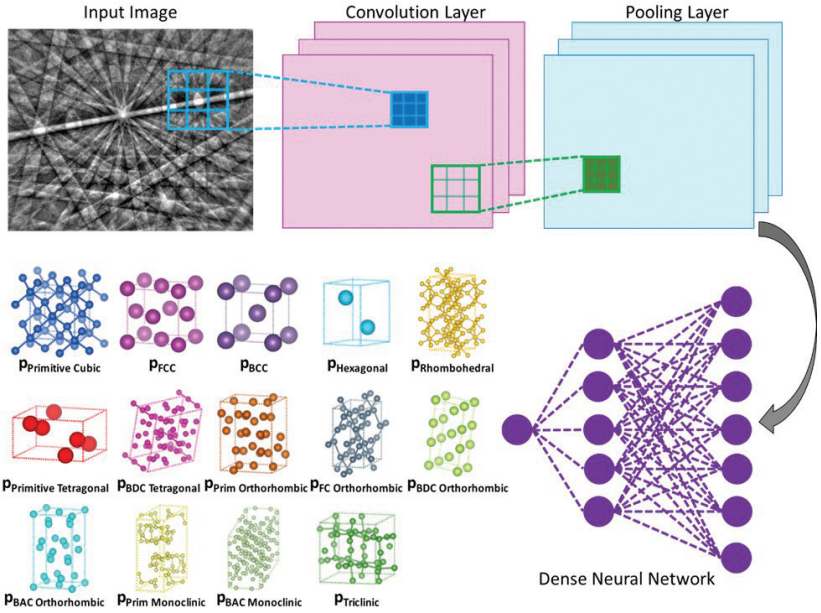
32. Description of Crystals : The anisotropic nature of crystals results in a freely growing crystal bounded by flat faces. Faces which are parallel to the same above are said to form a zone. The direction of the edge is the zone axis. The number and relative importance of the faces bounding the crystals of the same chemical compound may be very different. The crystals are then said to have different habit. The angle between similar faces is constant for different sized crystals of the same substance. This meant that a crystal grows by the parallel displacement of its faces.

A. Crystal Symmetry : Symmetry is the basic property of crystals. A crystal polyhedron can be brought into successive indistinguishable positions by non-trivial operations these are rotation, inversion around an axis over a specific angle.

B. Crystal Systems : The seven groups obtained when only the dominant symmetry elements of classes or taken into account are called crystal systems. In order of decreasing symmetry they are called as cubic, hexagonal,

tetragonal, orthorhombic, monoclinic and triclinic. Sometimes the tetragonal and triclinic are considered as a single system. The expression of cubic crystal means that the crystal belongs to the cubic system.

In practice the crystal is measured that in á and p values of the faces are determined under ploted in a thereognomogrm. Zone circles are drawn and the intersections give possible faces.



33. Distribution of Elements : From thousands of analysis of the rocks glacial soils and meteorites tables of relative abundance of elements in the continental crust. The oceanic crust and the mantle have been compiled and even some hypothesis about the earth's core have been advanced.

The earth's elements are distributed quiet unevenly – eight elements : Oxygen, silicon, aluminium, iron, magnesium, calcium, sodium and potassium account for the 90% of the weight of earth's crust. Many other elements occur only at concentration million of a percent. The mantle is believed to consists of ferromagnesian silicates, where as core is thought to be composed mainly of metals the siderophile elements some elements such as lead are rare in the world average but are highly concentrated in ores.

34. Drainage Patterns : A design of drainage pattern is the expression of inequality in rock hardness, initial slope, structural controls of a drainage basin. For example dendritic type develops as irregular branching on the rocks of uniform resistance of sedimentary massive igneous rocks.

The drainage texture is mostly influenced by the infiltrations capacity. It is commonly observed that the drainage lines are more numerous over impermeable strata than permeable ones.

35. Drainage Texture : It is an important geomorphic concept by which we mean relative spacing of drainage lines which drainage and stream densities are included. It is commonly observed that the drainage lines are more numerous over impermeable strata. Rather than over permeable ones. Naturally sands and gravel lack surface drainage bad land topography influences fine drainage texture. Valley flanks are developed by the lateral erosion of stream.

36. Earth – Surface and Layering of the Interior : The surface elevations are referred to a theoretical surface called the geoid. It can be visualized as the surface passing through the continents which the water table would assume if a rock were a porous and permeable mass which exerts no force on the water other than the gravitational force. The geoid departs from the approximating spheroid by 100m at most. The average density of the earth is 5.51gm/cm^3. Water covers 70.8% of the earth surface the land is unusually distributed. The oceans may be visualized as a series of basins separated by ridges. The ocean floors are covered by 1-3km of sediments. From them rise mountains of volcanic rocks in whole ranges, lines of cones are isolated peaks. These volcanic rocks appear to be different chemically from the rocks of the continents. The oceanic volcanoes produce only basaltic lava where as both basalts and more acidic extrusive are found on the continents.

The earth is surrounded by envelope of the gas, atmosphere. This is divided into two zones on the basis of temperature the lower most layer, troposphere contains about the three forth of the mass of the atmosphere and it is only the layer supporting the life as known on the earth it varies in thickness from 8-17km bulging at the equator. The tops of the highest mountains are all within the troposphere and most of the clouds and all of the weather experienced on the ground. The atmosphere becomes increasingly ionized with elevation because of the high concentration of electrically charged particles and thus upper atmosphere (ionosphere) is a good conductor of electricity.

Layering of the Interior : Most information about the earth's interior is provided by seismology. Earth contains three layers – The crust, the mantle, the core. The composition of the crust beneath the continents is believed to vary with depth. The rocks of the continents are largely silicates, aluminium rich at the surface (sial) grading to iron and magnesium rich at depth (sima). The sial is missing beneath the oceans at the lower boundary of the crust a sudden increase in seismic wave velocity occurs. This is known as mohorvicic unconformity.

37. Emerald : The medium to dark green gem variety of the mineral beryl. Crystallizing in the hexagonal system flawless emerald with good colours is highly prized of all gem stones.

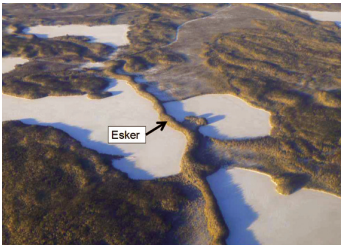
38. Engineering Problems Related to the Geological Aspects : Compressive strength : Most laboratory tests show that an in moisture in rick causes a decrease in its compressive strength and elastic modules in sedimentary rocks, the compressive strength is strongly dependent on the quality of the cement that bounds the mineral grains. The value of the compressive strength to be used in an engineering design must be related to the direction of the structure load and orientation of bedding in the foundation rock. This relationship is important because the highest compressive strength is obtained when the compressive stress in rocks. Shearing stresses tend to separate the portions of the rock mass. Faults and folds are example of shear failures in nature.

39. Environment of Deposition : The sedimentary environment is usually defined in terms of a complex of

physical and chemical conditions associated with a particular geo morphologic unit.

40. Escarpment : A cliff or steep slope of some extent, generally the margin of a plateau or the steep face of an assymetrical ridge. They are produced by faulting or erosion. Where ever differential rates of weathering occurs.

41. Esker : A sinuous ridge of constructional form consisting of glacial sand and gravel. Most eskers are the deposits made by streams flowing through tunnels near the base of ice sheet.



42. Evolution of Universe : One explanation for the observed expansion of the universe is the big bang theory in which all of the matter and radiant energy of the universe were initially compressed into a single object. For reasons unknown, this primordial egg exploded hurling matter and radiation outward in a slowly decreasing expansion that led to rapidly dropping temperatures. First quantities of helium were formed.

Only after the universe had expanded to where the temperature dropped 300k cooled galaxies began to form out of gravitational condensation of the expanding gas. Within these large condensation, smaller centers of contraction became the stars which today constitute the major fraction of galaxy mass.

43. Evolution of Ocean Floor : The difference elevation of continents and ocean basins attest to the differences in composition between continental and oceanic crust.

Continental crusts is thick (35-60k) and composed primarily of granitic rocks with density 2.7 oceanic crust is denser (density = 3) and only (5 to 10km) thick consisting of a carpet of sediment overlying thick piles of extrusive volcanic rocks. These volcanic rocks of the ocean crust are basaltic in composition and are characterized by tubular and bulbus pillow lavas are ropy textured plains pahoehoe lavas which are followed by volcanic rocks of plutonic type and coarse grained crystalline mantle. The oceanic crust is also much younger than the continental crust which is older at least 10^9 years.

The sea floor spreading theory postulates that new oceanic crust is continually being produced by the upwilling of magmatic material along the mid ocean ridge system.

44. Exfoliation : The splitting up of concentric thin sheets or shells from the surface of the massive rock of weathering process in moist climate. The process is particularly effective at the edges and corners of joint blocks where penetration can be from several directions. Separation of successive curved shells tend to produce increasingly rounded forms.

45. Fiord : A segment of a trough like glaciated valley partly filled by an arm of the sea. It differs from other glaciated valleys only in the fact of submergence. The floors of many flords are elongated basins exacted in bed rocks.

Fiords occur conspicuously in British Columbia and Alaska, Greenland and arctic islands, New Zealand and Antarctica all of which are rock resistant to erosion, with deep valleys. The depth of the valley are around 800m; The deepest on record is 1933m in skeleton inlet, Antarctica.

46. Fluvial Erosion Cycle : It results in landscape development in a sequence of steps from an initial uplifted mountain mass to a nearly plane surface.

A. Stages in Geographical Cycle : Davis visualized the cycle as beginning with the uplift of a landmass into mountains, erosion and transportation by running water are intensified by the topographic relief resulting from the uplift. In the first stage steep-sided valleys developed because of the large elevation between mountain top and sea level. This first stage may be considered as youth.

There follows a stage of maturity during which down cutting of valleys ceases because on equilibrium is established between the debris supplied from the eroding mountain mass and the ability of the river to carry it away finally as a result of a very long period of this condition called old age, mountains are reduced to low and insignificant mounds on the extensive plane surface or peneplane. Thus the sequence from the youth through maturity to old age can be viewed as a geographical cycle of erosion.

B. Fluvial Erosion of Land Forms : There are land forms that result from the erosion by running water on the surface of the earth. This water may concentrate in

channels as streams; rivers or run in thin sheets down slope. All land surfaces even those in the driest deserts of subject to modification by running water.

C) Factors Affecting Fluvial Erosion :

i. Direct lifting the dislarged material and carry it downstream.

ii. Abrasion and impact the solid particles carried by the stream can where down bedrock portions of the stream channel.

iii. Cavitation : A stream velocities of 25 to 30ft/sec cavitation can be affective.

iv. Salution : Enormous quantities are carried in suspension and desolution to the oceans.

v. Undercutting : A stream that erodes laterally by one or more above processes may undercut the channel bank or valley walls to the extent that the gravity causes material to slump into the river where it is moved downstream.

47. Fossilman : All pre-historical skeletal remains which are archeologically earlier than meolithic regardless of mineralization of fossilization of the bone and regardless of whether the remains may be classed as “homosapians”, the modern man.

Remains have come from Europe and adjacent protions of asia, from Africa, north China and Java. Because of the last entry of the human into the new world, American Indians are all of relatively recent origin and recognization as homosapians. The family man was once

thought only to have come into existence at the beginning of Pleistocene. It is known to have fully separated from the family of the apes not least as far as back of the “Miocene”.

Man is a caterhine primate part of group including old world monkeys apes. The oldest known representatives of the catarhine are fossils from the fayum beds of north Egypt dated around 30m.y. of old. The best known of these is aegyptopithecus Zeuxis, a possible ancestor for apes and humans. This animal was the size of a cat, with a monkey like body ape like teeth and a distinctive skull a mosac of evolutionary features. Between about 15 and 23m.y of age in the early Miocene, several species of dryopithicus in east Africa represent relatives of ancestors of humans. These apes ranged in size from small chimp to small gorilla. Evidence from both morphology and molecular studies or proteins shows that humans closest living relatives are the African apes, the chimpangies and the gorilla.

48. Fundamental Mechanism - Plate Tectonics : The plate tectonic model indicates that mountain building results from two fundamental mechanisms. Island arc cordilleran orogeny for the most part thermally driven occurs along the leading lithosphere plate edges above

subduction zones. Continent – Island arc or continent – continent collision orogeny is for the most part mechanically driven and occur subsequently to island arc development or during final closing of ocean or both. Widely rates of consumption, volcanism and deformation along consuming plate margins result because of varying distances from the poles of rotation of involved plates.

49. Future of the Universe : The current expansion of the universe is the product of "Big Bang" explosion and the rate of expansion should be less than the original rate because of the gravitational slowdown produced by the matter of universe when it was still small and dense. How long the universe continue will depend on whether or not the explosion was stronger than the force of gravity due to all the matter of the universe. If the gravitational force is not so pronounced, the expansion of universe is slow down.

50. Genetic Classification of Rocks :

a. Igneous Rock :

i. Intrusive – plutonic (deep)

Hypbssal (shallow)

ii. Extrusive – flow

Pyroclastic (explosive)

b. Sedimentary :

i. Clastic (mechanical or detrital)

ii. Chemical (crystalline or precipitated)

iii. Organic (biogenic)

c. Metamorphic :

i. Cataclastic

ii. Contact metamorphic and pyrometasomatic

iii. Regional metamorphic (dynamo thermal)

d. Hybrid :

i. Metasomatic

ii. Migmatic

51. Geo Chemical Prospecting Surveys : Geo chemical prospecting surveys are generally classified according to the type of materials sampled. These include litho geo-chemical surveys, pedo geo chemical surveys hydro geo-chemical surveys to mineral deposits.

a. Litho Geo-Chemical Surveys :These are not used extensively as others. Only reconnaissance surveys are carried out on grid pattern and sampled by test drilling taking core samples and rock samples from exposures and a rough estimation may be done based on the areal distributions.

b. Pedo Geo-Chemical Surveys : Soil and glacial till surveys have been used extensively and have discovered numbers of ore deposits. Similar surveys may be used for locating petroleum pools. In glacial terrains boulders and fragments are found as indicators of gold – quartz veins and galena boulders of fragment as indicators of lead – zinc deposits.

c. Hydro Geo-Chemical Surveys : These include water surveys, heavy mineral surveys and sediment surveys. In case of water surveys, surface water or ground water may be sampled. An increase in the metal content of the water

upstream may indicate the approach to a mineralized zone surveys based on ground, water sampling may be done where there is good number of well distributed.

52. Geo Physical Prospecting : Geophysical prospecting find its importance in ground water, surveys to locate sites for the construction huge building with regards to the stability status of the area in well logging etc.

For ground water prospecting the resistivity of the layered rocks at the site are recorded by resistivity meter. Based on resistivity ranges, the weathering potential of the spot under in investigation, depth of weathering which raves the way for the assessment of ground water availability based with physio graphic features and hydrological flow lines, the site is selected for construction of ground water structure.

Even for the granitic and other mining operations the geophysical surfaces are of importance in locating the granitic reserves by test drilling to obtain core samples which indicate the availability of reserve.

53. Geo-Chemical Prospecting : Either surface water or ground waters may be tested in water surveys, depending on local conditions. Surface waters are sampled at regular intervals along the drainage net and a map of the values is prepared. An increase in the metal content of the water upstream may indicate approach to a mineral to a mineralized zone survey based on ground water can be done only where there is a good distribution of wells, springs or diamond drill holes. The metal content of the water in these is plotted on a map and contoured higher than normal contents in the water systems may indicate sites or zones of mineralization. Extensive surveys of this type are being carried out in candian shield.

54. Geode : A roughly spherical hallow body lined on the inside with inward projecting small crystals. Geodes are found more frequently in lime stone beds but may occur in shales also. Typically a geode consists of a thin outer shell of dence chalcedonic silica and an inner shell of quartz crystals, beautifully terminated pointing towards the hollow interior. Many geodes are filled with water others are exposed for sometime at the surface are dry.

Calsite or dolomite crystal line the interior of some geodes almost all geodes show some banding suggestive rhythmic precipitation.

55. Geologic Distribution of Plant Groups : The fossil record of the plant kingdom shows the major plant groups have varied considerably in time of origin, geologic range and period of maximum development and decline. Clearly demonstrating the theory of evolution. The earliest plant belong to the simpler groups and the later ones become more complex progressively. Modern land vegetation is thus a composite made up chiefly of the most highly complex plants. The flowering plants, Living in association with a lesser number of survivors of simpler types of plants.

56. Geological Time Scale : The assignment of time in years to each geological period. The fossils record of life and the deposition orogenic earth history events provide the basis for the relative time scale accepted by all geologists.

The actual time in years before present is based on the regular decay of radioactive isotopes found in minerals. This decay results in a series of elements, each having fewer atomic numbers. Decay rates are the ratios of the

amounts of daughter isotopes to parent isostope in a rock sample.

Isotopes age determinations are made primarily on igneous and metamorphic rocks. The uranium and lead series is used mainly in determining the age of such igneous rocks as granites. potassium argon and rubidium and strontium methods are used on micas found in granites which are intruded in fossilierous strata.

ERA	Period		Epochs
Cenzoni	Quantern		Holocene (recent)
	Tertiary	(neogene)	Pleistoncene
	Miocene		Oligocene
Mesozoic	Cretaceous		Eocene
	Jurassic		Paleocene
	Triassic		
Paleozoic	Permain		Pennisyllania
	Carboniferous		Missipin
	Devonian	Silurian – gothlandian	
		Ordovisian	
	Silurian		
	Ordovician		
	Cambrian		

(See the illustration in the end)

57. Geology : As per the present subdivision the branches of geology may be outlined as follows.

A. Physical geology :

i. Minerology

ii. Petrology

iii. Weathering and Erosion

iv. Sedimentation

v. Structural geology

vi. Economic geology

B. Historical geology :

i. Stratigraphy

ii. Paleontology

C. Geological Mapping : Graphic representation of bed rock units defined by physical characteristics and geologic age.

58. Geology Evolution : The evolution of geology as a science has stemmed from the successive development of three contrasting doctrines. Each views the earth form a fundamentally different analytical perspective.

59. Geo-Technical Investigations : For engineering projects, these investigations are preliminary studies, preconstruction or design investigations, consultation during construction and the maintenance of the complete structure.

a) Preliminary Studies : The first step in this study is the search for published material in libraries with respect to topography and local geological maps. Oil companies will occasionally release the geologic logs of any drilling in the project area. The topography maps and air photos can

be used to study rock outcrops, drainage patterns, land forms, geologic structures. The nature of soil and vegetation field reconnaissance may include the collecting rock and soil samples, inspection of road cuts and other excavations and also location of source material for construction surface studies include the preparation of detailed map of surficial geological map.

Subsurface investigations are required to confirm and amplify the surficial data. These may include testpits, trenches, short tunnels and drilling of vertical, horizontal or oblique boreholes and the geologic data obtained from these may be confirmed with geophysical investigations the geology disclosed by subsurface investigations is logged on appropriated forms. Tunnels logs display visual measurements of fractures and joint orientations. Geophysical seismic methods may be used to define the thickness of loosened rock around the tunnel; electrical resistivity data may be obtained by electrical logging to define their porosity, moisture content and thickness. Geotechnical supervision is desirable during construction in or on earth media.

During the operation and maintenance of a completed project, the service of engineering geologist are often required to determine causes an assist in the preparation of corrective measures for cracks in lining of water tunnels. Excessive settlements of structure undesirable seepage in the foundations etc.,

60. Geo-Technical Significance of Soils : Glacial and alluvial deposits contain heterogenous mixtures of pervious (sand and gravel) and impervious (clay, silt and clay) soil materials the perivous materials can be used for high way

sub grade, concrets embankments and filters and pervias zones of earth fundamentals. Dam reservoir may be endangered by the presence of stratified or lentcular bodies of pervious materials or ancient buried river channels filled with pervious material. Deep alluvial deposits in or close to river deltas may contain very soft materials such as organ, silt or mud. An unsuitable soil that has been found in dam foundations is open work gravel. Concrete of earth dams can be built safely on sand foundations. Clays supporting structures may consolidate slowly over a long period of time and cause structural damage.

61. Geyser : The natural spring or fountain which discharges volume of water or stream in to the air at regular intervals. It may be regarded as a special spring. Perhaps, the best known area of geysers is the yellow stone park, U.S.A. where there are more than 100 geysers and more than non-eruptive 3000 hot springs. Discharge height of steam or water from geyser is about 250ft or above. The eruptive action of geyser is believed to result from the existence of very hot rock. The relic of a body of magma, not for below the surface.

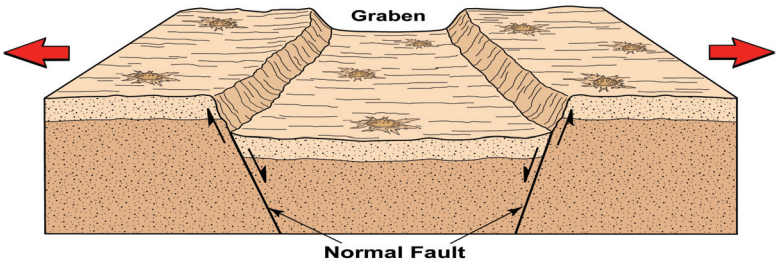
62. Glacialogy : the study of naturally accumulating masses of glaciers. A glacier is a naturally accumulation mass of ice that moves in the process of discharging from head or centre to its margins. Glaciers are nourished in areas of snow accumulation and are active in heaviest snowfalls such as the maritime flanks of high coastal mountain ranges. The glacial terrain is a region distinctive because it ones bore great masses of glacial ice which may

have been either mountain or mountain and valley type where high ridges and peaks protected above the ice.

63. Gneiss : It may be rock having much importance to the structural pattern in rather than the compositional substances. Thus it applies to a great variety of rocks with a banded of coarsely foliate structure.

Typical gneisses are highly metamorphic or coarse grained irregularly banded or foliated rocks composed of quartz and feldspar and biotite.

64. Graben : A block of the earth's crust generally with a length much greater than width, that has been dropped relative to the blocks on either side. The size of the graben vary. It may be few inches long or it may be hundred miles in length. The fault that separate a graben from adjacent rocks are inclined from "50-70ft" towards the downward block and have displacement ranging from inches to thousands of feet. The direction of slip on these indicates that they are gravity faults grabens are found in region where the crust has undergone extension. They may form in the crusts of anticlines or domes or may be related to broad regional warpings.



65. Gravity Fault : This drip of the gravity faults have a maximum frequency of about 60ft" suggesting at the time of faulting. The greatest principle stress was oriented approximately vertical and the intermediate and the least principle stresses are nearly horizontal in many cases, two or more are parallel to one another step faults are parallel displacements on which the down thrown side is on the same side of each fault.

66. Ground Water Accumulation :

A. Hydrologic Cycle : Both ground water and surface water are related to hydrologic cycle. Evaporation takes place from oceanic and other water bodies which leads to cloud formation. During congenial climatic condition condensation takes place resulting precipitation and reaches the surface of earth in the form of rainfall.

This rainfall takes different routes as run-off feeding the tanks, rivers and all other surfaces reservoirs and thus flow towards oceanic bodies, some of the water enters into the soil and form as ground water reservoirs and some of the water will be taken by plants and part of it will be discharged into the atmosphere as vapour in the process of transpiration and the cyclic process will be completed. The ground water resulted in this way for our daily routine life is of meteoric origin named as meteoric ground water in this regard, it has to be noted that surface water is visible everywhere but ground water is invisible hidden beneath the surface of the earth.

B. Formation of Ground Water Reservoirs : Ground water enters in the surface of the earth by two

processes known as infiltration and percolation. "Infiltration is the forceful penetration of precipitation". In the permeable soils of effective porosity from effective rainfall based on the structural pattern of interconnected interstices (openings), the infiltrated water transmits or travels moves through them and are arrested by impounding bodies or clay barriers and thus form as ground water reservoirs. This process is known as percolation. The velocity of the percolating water will be in accordance with the Darcy's law which states that it is directly proportional to hydraulic quadient and inversely proportional to the flow length.

67. Ground Water – Velocity : The velocity of ground water is in accordance with the Darcy law. The Darcy's law states that the velocity is directly proportional to hydraulic gradient and inversely proportional to flow length.

68. Ground Water Surveys : Ground water investigations may be studied under three categories.

i. Hydrogeological surveys

ii. Geophysical surveys

iii. Hydralogical surveys

i. Hydrogeological surveys : In this type of surveys, the terrain conditions such as weathering and gradients of the rock formations well field in the, vicinity of the area based on the discharge of the well, structural patterns observed in the well, favourable physiographic features, and drainage patterns of the area are to be recorded. Correlating the favourable observations in the well field, sites may be selected in the area under investigation

ii. Geophysical Surveys : The geophysical surveys are essential in arriving at the weathering conditions of the hard rock. Based on the resistivity recorded by resistivity meter, the joining, fractured zones may be identified by plotting and drawing the curves which may be compared with master curves. Ground water structures may be constructed based on the resistivity ranges which may be properly interpreted in the area under investigation. In some places such as concrete based areas, the resistivity meters could not properly record because of distortions.

Parametric soundings may be conducted. If there are structures already constructed for the sake of correlation.

iii. Hydrological Surveys : The hydrological surveys are more important for budgeting the ground water reserves to be utilized in a systematic manner.

a. Proper stipulated spacing should be followed to avoid interference effects leading failure and less yield because of cone of depressions.

b. As per the extent of potential area the no.of ground water structures should be constructed for safe yield.

c. The observation wells may be set to study the water level fluctuations in response to draft rainfall in the vicinity of the area.

d. To accomplish artificial recharge, water shed management may be takeup And harvesting structures such as check dams percolation tanks may be constructed to augment the water supply.

If all the three types of surveys are properly conducted utilization of ground water may be done in an efficient manner.

69. Gulf Coast of USA : They are so important because of their association with oil and sulphur deposits. Where the salt has intruded petrol ferrus sediments. The resulting deformation often forms traps in which oil accumulation occurs.

70. Hydro Thermal Deposits : Most vein and replacement deposits are believed to be the result of precipitation of mineral matter from dilute hot, ascending fluids. As the temperature and pressure decrease, deposition of dissolved materials takes place. Such deposits may be called as hydrothermal deposits.

Based on the temperature and pressure conditions, the hydrothermal deposits may be studied under three groups.

a. Deposits formed between the temperatures ranges of 50-200R"C a below the surface of the earth are called 'epithermal' many minerals mercury, gold, silver, antimony are of this type.

b. Deposits that are formed at shallow depths between the temperature range 200-300R"C, such deposits are called 'meso thermal' mineral which include under this type are gold, quartz, silver and lead etc.

c. Hypothermal deposits are formed at higher pressures at the temperature range of 300-500R"C. Under this tin, tungsten, gold, quartz may be exemplified.

71. Hydrograph : Hydrograph may be defined as the graphical representation of fluctuating water levels in response to rainfall during period of unit dimensions in cyclic process. It may be taken as the graph showing the time distribution of the water level in well or stage of the river normally, the hydrographs are drawn taking the normal for one year during the decade. The normal rainfall has to be taken as the datum line for computing the data of water level fluctuations in response to different intensities of rainfall in different months.

72. Hypabyssal Rocks : These rocks exhibits characteristics more or less intermediate between those of plutonic and volcanic rocks. They differ from volcanic rocks in that they are intrusive and lack of glass an vescicular structures. They differ from plutonic rocks in that they occur in small bodies (dikes and sills) and formed at shallow depths as 'lacolith'. The texture are resulted from rapid cooling.

73. Ice Berg : Alagre mass of glacial ice broken off and drifted from parent glaciers or ice shelves along polar seas.

74. Ice Field : A network of inter connected glaciers or ice streams with common source area or areas in contrast to ice sheets. And ice caps which are dome like glacial mass with relatively flat surface where as ice caps are properly defined as dome-like glacial masses at high elevations.

75. Intra plate Basins : The intra plate cratanic basins that were termed autogeo-synclines seem to relate to the stability of continental plates, for they are present in north America Paleozoic craton but apparently not in the European Paleozoic plate. The European plate moved over the mantle towards the north American plate in closing the ancient ocean that was formed.

76. Isostacy : A theory of hydrostatic equilibrium in the various parts of earth's crust. All the large land masses on the earth surface of the earth tend to sink or rise so that given time re-adjustment has to be taken up without disturbing equilibrium. During the diastrophic movements, earthquakes causing tremors, and subsiding are the signs of such re-adjustment of equilibrium.

77. Jointing Pattern : A fracture that traverses a rock and thus not show any discernable displacement of one side fracture relative to another. The term joint refers primarily to the actual fracture as represented by a fine line or trace marking the intersection of the fracture and rock surface.

A. Varieties of Joints : Joints fall into two major classes based on their spatial relations geometry and surface structures – systematic and non-systematic joints.

Systematic joints are arranged in group of regularly spaced parallel or sub parallel planer fractures called joint sets. Two or more joint sets comprised a joint system. In sedimentary rocks joints are parallel to the strike or dip of the strata. In igneous and metamorphic rocks systematic joints are described on the basis of their geometry relations joints originate as a direct result of deformation may be called as first order joints another type from a re-adjustment of spaces following first order jointing, faulting are folding may be considered as second order joints.

Columnar or prismatic joints : Columnar joints occur in a sheet like or a plug like intrusive and extrusive igneous bodies indivisible columns are five or six sided and may have 3 to 8 sided from some examples. The columns range from a few inches to several feet in diameter. Columnar joints are oriented normal to cooling surface and results from the contraction of the igneous rock on cooling.

78. Leaky or semi confined Aquifer : That is a completely saturated aquifer which is bounded above by a semi-pervious layer and below by a layer either semi-perviour or impervious.

79. Lithosphere Plate Tectonics : Lithosphere plates are spherical segments of upper mantle and crust varying in thickness from 5km of ridges to 150km under central areas of continents. Plates are generated accreting plate margins such as the mid-Atlantic ridge between America and Africa plates.

Plates move symmetrically away from ridges over the low velocity channel of the mantle with the rates ranging from 1cm to 10cm per year. Their motions are decided by poles of rotation with respect to one another. Continental masses such as Africa and Australia are nearly passive passengers on evolving plates. Continental drift is prescribed by plate evolution.

80. Marl : An argillaceous, non-indurated calcium carbonate deposit that is commonly blue gray or gray. It is somewhat friable, and in respect resemble chalk. It is formed in fresh water lakes, partially by the action of some aquatic plants. The plants extract carbon dioxide for photosynthesis from bicarbonate in the water and locally reduce solubility of calcium carbonate next to leaves, where it precipitates. The precipitate form a scale which accumulates at the bottom. Marl stone or marlite is an indurated rock of the same composition as marl.

81. Mass and Weight - Gravitational Force : The mass of an object is the quantity of the material of the substance where as its weight is concerned with the gravitational force of earth. Hence the mass of the object may be same both on moon and earth. But it differs in weight due to the differential gravitational forces of moon and earth. Hence the weight of the object is higher on earth than on the moon whose gravitational force is less than that of earth.

82. Massif : A block of the earth's crust commonly consisting of crystalline and schists. The textural appearance of which is markedly different from that of the surrounding rocks common usage indicate that massif has limited areal extent and considerable topographic relief.

Structurally, a mass may form the core of an anti clinic or may be a block bounded by faults or unconformities. In any case, during the final stage of its development a massif acts as a relatively homogeneous tectonic unit which controls the structures that surround.

83. Metamictization : The amorphous state of substances that have lost their original crystalline structure because of the radio activity of uranium and thorium. The process rendering crystalline substances partly or wholly amorphous is known as "Metamictization". Minerals whose crystal structure has been disrupted by this process are known as "metamict minerals".

The metamict minerals exhibit anomalous optical behavior, pyrognomic behavior such as incandescent on heat lacking of cleavage, exhibiting conchoidal fractures, resistance to attack by acids, reconstitution of crystalline structures on heating many of these minerals are characteristic of pegmatities and also in hydrothermal deposits.

84. Meterorite and Meteroids : Any natural solid object that falls to the earth from space and retains its primordial characteristics. Such objects are rare and they differ from all terrestrial rocks in their composition there are only 2200 meteorites known over the entire world and were named after the place where they were found.

Meteroids are attracted to the earth if they are moving through objects and bring them to the earth's gravitational field. As they are small, most of them are consumed in their flight and hence only very large sized objects only reach the earth in fragmental state hence our

atmosphere is a naturally occurring protecting shield for living beings in some places, these meteorites which are named after their places which gained the importance of pilgrim centers.

Ex: Black rock of mecca and the casa grande meteorite of mexico are popular as sacred symbols.

85. Migmatite : Rocks originally defined as original character due to intimate mixing of older rocks (shist and gneiss) with granitic magma. Now most plunotic rocks of mixed appearance are called migmatites commonly they appear as veined gneisses. The process is known as migmatization. Several modes of origin proposed.

a. Granitic magma may be intercalated between thin layers of schist (Lit-Par-lit-intection) to form a banded rock called injection gneiss.

b. The granitic magma may form in place by selective melting of the rock components.

c. Granitic layers may develop by metamorphic differentiation (Redistribution of minerals by recrystallization).

d. The granitic layers may represent selectively replaced or metasomatized portions of the rock veined gneisses include two genetic types.

Arterites : In which the vein material was injected and veinites in which the vein material was secreted from the rock itself. Migmatites are found in zones of marginal intrusive of granite. And also in the zone of ultra metamorphism.

86. Moho (Mohorovcic Discontinuity) : A seismic discontinuity at the base of the earth's crust inferred from travel time curves indicating that seismic waves undergo a sudden increase in velocity of seismic compressional waves, increases to a little over 8km/sec. The discontinuity is named after its discover seems to exist every place as per the geophysical investigations intended for the seismological structures of the earth. Under the ocean basins, the depth is 10 to 1km. Under the continents it is usually at the depth of 33-35km. It is usually deeper under mountain masses and shallower under low lands and plains.

87. Moon – Structure and Origin : The earth's natural satellite, target to the first attempts by humans to reach another world. Apolo11 astronauts landed on the moon on July 20th 1969 all the satellites in the solar system the moon is the largest in proportion to its primary. Theories of origin include

i. Dependent Condensation and then captured by the earth.

ii. Formation in the same cloud of pre planetary matter in the earth.

iii. Fission from the earth.

The earth and moon now make one revolution about their barycenter of mass. The moon is too small to have compressed it's silicates into a metallic phrase by gravity. The moon have no radiation belts only a slight magnetic field and behave as a non-conductor in the presence of interplanetary field. Erosion is more active. The lunar mountains though very high (8000m) are not extremely

steep. Though the wide mountainous regions bordering on the maria are found sinuous rillers.

88. Moraine : An accumulation of glacial drift deposited chiefly by direct glacial action.

89. Mountain System : Defined by some authorities, cordillera, cordeliran belts fold belts or mountain chains. A major part of each continent is made up of mountain systems, although, some mountains are geologically old and much subdued by erosion.

Some systems are young and have incessant earthquake activity such as the coast ranges. Some have been built in two or more stages such as "Sierra Nevada".

Another type of mountain systems may consists of huge piles of volcanic rocks that have been built around volcanic vents.

During the course of the movement of plates, ocean basins may be closed as continents collide and the leading edge of continent may become crumpled as oceanic crust is paused beneath the edge of the continent in a subduction zone. In either case mountain chains are created. The former process creates collisional alpin- himlayan type and the later, cordillera type mountains such as "Andes".

90. Mud Volcano : A conical landform composed of clay and silt with variable mixtures of sand and rock fragments, the whole resulting from eruption of wet mud and impelled upward by fluid or gas pressure.

91. Natural Gas : A combustible gas that occurs in porus rock of the earth's crust is found with or near accumulations of crude oil. Being a gaseous form it may occur alone in separate reservoirs. Under conditions of greater pressure it is intimately mixed with or dissolved in crude oil.

Typical natural gas consists of hydrocarbons having a very low boiling point. Methene (CH_4). The first member of the paraffin series and with a boiling point of -254F make up approximately 85% of the typical gas ethane (C_2H_6) with boiling point of -128F may be present in amounts of 10% and other are propane, butane are also present in smaller quantities.

Gas occurs on every continent wherever oil has been found. A certain amount of natural gas is also present. In production and known reserves the united states stand first among nations.

92. Ocean and Sea : The inter connecting body of salt water that covers 70.8%. Surface of the earth is called "The Ocean". Sub divisions corresponding to the continents are called as oceans. Subdivisions of ocean in turn are called seas.

93. Oceanography and Meteorology – Atmospheric Science : The atmospheric sciences commonly grouped together as meteorology, are concerned with all chemical, physical and biological aspects of the earth's atmosphere. Although, the study of weather is used to be the chief occupation of meteorologist, man's entry into space age calls for a vast increase in the knowledge of environment. Consequently many aspects of the atmosphere are now being studied intensively for the first time.

Oceanography encompasses the study of all aspects of the oceans: Their history, composition, physical behavior and life content. During the 2nd world war, many important characteristics of the ocean were discovered.

94. Oil Field Waters : Waters of varying mineral content which are found associated with petroleum and natural gas. They are called as field brines or brines. They include variety of underground water, usually deeply buried and have a relatively high content of dissolved minerals.

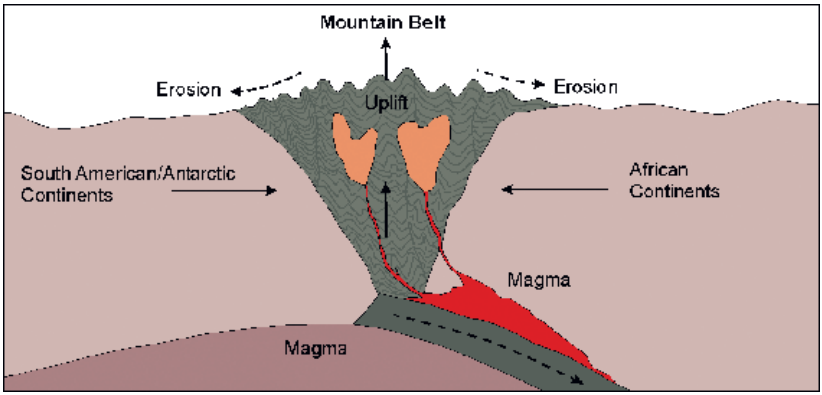
95. Oil Sand : A loose and semi consolidated sand stone impregnated with heavy asphaltic crude oil which is highly viscous to be processed by normal methods. This is also called as tar sand.

96. Origin of Soil : Soil formation proceeds in stages, but these stages may grade indistinctly from one into another. The first stage is the accumulation of unconsolidated rock fragments; the present material parent material may be accumulated by deposition of rock fragments, moved by glacier, wind, gravity or water in place from physical and chemical weathering or hard rocks. The second stage is the formation horizons. Soil horizons are the result of dominance of one or more processes other producing layers which differ from the layers above and below.

97. Orogeny : The process by which mountaineous tracts such as alpine-himalayan, applachain and cosdilearn orogenic belts are formed, also known as “orogenisis”. Characteristically orogenic belts are long, linear or arcuate with distinctive zones of sedimentary, deformational and thermal patterns that are general, parallel but a symmetric to the belt. Typically, orogenic belts are sites of abnormally

thick. Accumulations of sedimentary and volcanic rock and severe deformation and thermal alteration of global, continuously evolving system of oceanic ridges and trenches, according concepts of sea floor spreading or currently litho sphere plate tectonics.

Lithosphere plates are spherical segments of upper mantle and crust plates move symmetrically away from ridges over the low velocity channel of mantle. With rates ranging from 1 to 10 cm per year. They move as rigid masses.



98. Orpiment : A mineral having composition of As_2S_3 (arsenic sulphide) and crystallizing in the monoclinic system. Crystals are small, tabular and rarely distinct. The mineral occurs more commonly in foliated or columnar masses. There is one perfect cleavage yielding flexible folia which distinguishes from other minerals similar in appearance. The luster is resinous and pearly on the cleavage surface is lemon yellow occurs in veins of lead, silver and gold. It is mostly found in Romania, Japan, Peru,

U.S.A., and Soviet Union and also from geyser waters at yellow stone park, Colorado (USA).

99. Paleo Bio-Chemistry : The study of chemical processes used by organisms that lived in the geological past. Most information on the nature of life in the geological past comes from the study of fossils. A recor of biochemical processes that occurred can be found in the organic molecules of sedimentary rocks and fossils. The organic matter in the fossil fuel deposits (coal, petroleum etc.) and finely dispersed in shales and lime stones represents the debris of the cells which have been altered to more stable form. Consequently, the bacterial and chemical transformation occur on the death of the organisms.

A. Alkanes : Structural hydrocarbons (Alkanes) are among the most stable organic compounds and represent transformation products.

B. Tetrapyroles Comonds : Molecule with tetrapyrole ring structures, such as chlorophyll and hemin are used by all living organisms as either photosynthetic or respiratory pigments.

C. Amino Acids : The structural units of proteins are amino acids : of which are only more stable. They are alkanine, glycine, glutamic acid, leucine, isoleucine, proline and valine.

100. Paleo Botany : The study of fossil plants and vegetation of the geologic past. As a branch of paleontology, it contains the knowledge of geology and botany its materials are the fossilized remains of prehistoric plants preserved in the rocks including fossil leaves, seeds, pollen, fruits and flowers.

Plant Fossilization : In living forest accumulation of plant debris normally disappear as the result of natural processes of disentigration and decay. When forest grows in or adjacent to areas of sedimentary deposition such as swamps, lakes and rivers and streams plant debris may be buried along with the sediments. In course of time, under proper geological conditions, such sediments become sedimentary rocks and the burial plant remains become fossilized. The plant fragments most likely to be preserved as fossils are those possessing hard tissues that resist decay. Most fossil plants are found inshale and fine grained silt stone which are the lithified mud of ancient deposits. Compression and petrification may lead to the fossilization. To the geologist, the record of fossil plants added to that of fossil animals supplies the knowledge of change in panorama of the earth's history. Based on the geologic age of the rocks in which they are found.

101. Paleo Ecology : The ecology of the geologic past a study of the relations of fossils organisms to each other and to the environments in which they lived. Paleo ecology is a study based on interference and interpretations and on the basic assumptions that the animals and plants lived under essentially the same environmental conditions as do living relatives.

All types of environments in paleo ecology are to be considered : marine, brackish, freshwater and land areas. Marine environment has received a major share of attension because most of the fossils that make up paleontological record are contained in sediments that were deposited in the sea. Some paleo ecological interpretations are based

on the data obtained from the fossils themselves, others on features of the rocks that contain the fossils in many cases data from both the sources are used.

102. Paleo Geography : In Devonian times the continents are quite differently arranged than they are today. Paleo magnetite and geological evidence indicates that Europe, Greenland and North America were joined together as a single continent laurasia which was tropical in position. Similarly the present southern continents of India, Australia, America, Africa and South America were united as a single huse continent called gond wanaland.

The southern pole lay in the region of Southern Africa or South America with Gondwana land situated such that North Africa and Australia were closest to the equater. Marine waters covered large areas of these continents.

Certain belts of thick sediments occur in the Devonian period forming geo-synclinal tracts. In western north America, abroad geo-synclinal tract called usually cardilleran geo-synclinal streatched from Alaska to Mexico.

103. Paleo Geology : The geology of the past but a term applied to the interpretation of the rocks at a surface of unconformity an erosion surface concealed by the deposition of overlying sedimentary rocks. A paleo geological map showing the distribution pattern of rocks beneath an unconformity can be interpreted like a geologic map of the present surface permitting recognition of such structural features as anticlinic and synclines having older and younger rocks on their axes. Such maps suggest the possibility sities of petroleum reservoirs. Beneath

concealing sediments and indicates likely channels of fluid migration such buried paleo channel are productive for the ground water development mostly in alluvial tracts of the rivers.

104. Paleocene Hominidae and Present H.Sapieas : Ausrolopithecus, the first truly human like beings appear in the fossil record in 3m.y ago during the Paleocene one particle jaw with a single tooth has been found that may be as old as 6m.y old and few other fragments are bit younger. But the majority of the more compete finds date between 2-3m.y ago.

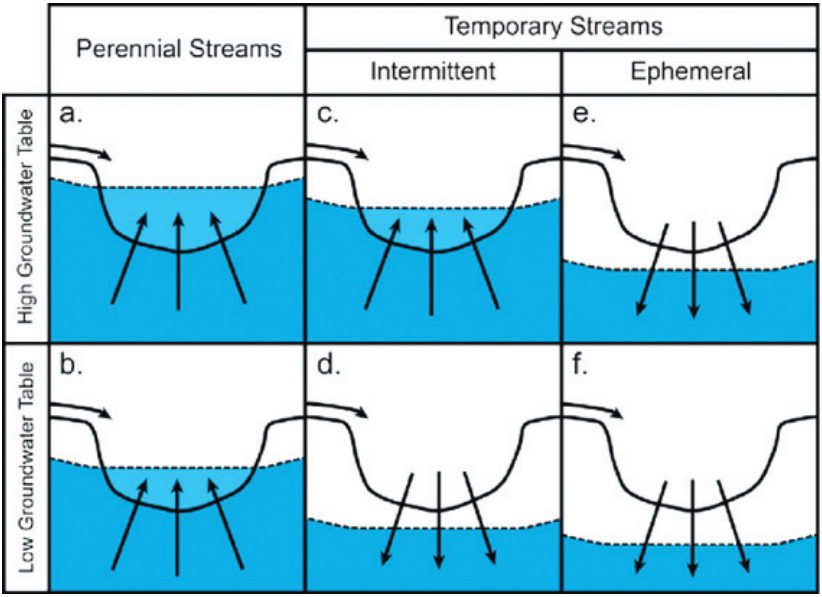
The south African fossils come from five sites which are the remains of cave systems. These hominids did not live in caves; but their cacasses may have been dropped there by leopards or other carnivores. Int two sites, especially many fossils are known from a relatively short span of time (50,000), but the evidence for dating is not definite.

In early pleostocene, the only other genus of the family hominidae is homo, true humans into which all later forms (including ourselves) are placed. The earliest known representative are once again from east Africa dating from 1.5 to 1m.y ago. In case of pre-modern h.sapians, it is possible that the glacial climate in Europe at this time was the impetus leading to the evolution of h.sapiens, modern type humans.

105. Pene plantation : Burried topography surface of sufficiently low relief to be considered peneplaines as sign of pene plantation. Pene plains are the result of coalescing

pediments with rock floored plains adjacent to mountain ranges draining into interior basins. Pediment are depressed on plain areas. In which rock masses are pushed into the ground.

106. Perennial Sources : Perennial sources is a broad term which includes the perennial rivers, perennial streams perennial springs and so on. In case of perennial streams, the continuous water supply is accomplished by the influence of both surface water and ground water. Especially we observe such structures in command areas of network of irrigation channels under conjunctive use of both surface and ground waters. Hence in case of fluctians of water supply, streams may be considered as intermitant streams. In case of effemeral channels, the water supply is in resonance to rainfall.



107. Permeability : This is the ability of sediment or rock to transmit water to allow water to pass through the connected pores a material may be porous and yet be impermeable because of the minute size of the pore spaces which hinder the movement of water. Ex: pumice.

108. Perthite : The natural glass with abundant spherical or convolute cracks that cause it to break into small pearl like masses or pebbles usually less than cm across. It is commonly gray or green with pearly luster.

After increases the volume by heating the aggregated are used in insulations, fillers, filters etc.

109. Petrification : This is an important process of fossilization. In this process ground water carry in bulk concentration of many minerals in solution. This mineral bearing solution may circulate through the plant materials buried in rocks of sediments and thus producing petrification. Hence the petrification occurs due to the infiltration of mineral matter in ground water into the buried plant remains. This concept has masked the molecule replacement concept.

110. Physiographic Provinces : Portions of the earth's surface that displays a similar array of land forms and relief features. Relief refers to those forms of surface roughness which determines and define the highest and lowest elevations within the province. The origin of the individual land forms within a given physiographic province may be determined through the geologic sub science of geomorphology.

Physiographic provinces are usually natural areas defined on the basis of a certain obvious landscape characteristics features. Such as topographic or "Lay of the Land".

The Terms 'Dissection' or 'incision' are used to describe linear erosion by running water that forms gully, ravine, valley, canyon with intervening ridges or more or less broad drainage divides.

The following examples may be listed under important physiographic provinces

i. Continental shelf

ii. Coastal plains

iii. Pied mont provinces : This is a moderate to low relief, slightly elevated area of deformed rock with dissection by streams flowing on rocks of varying resistance to erosion.

iv. Valley and ridge province : This province elongate ridges and valleys developed on strongly folded, layered sedimentary rocks. Rock layers vary in resistance to erosion.

111. Pieziometer : It may be defined as a bore well or tube well with automatic water level recorder intended for recording ground water levels in resonance to fluctuations due to rain fall or draft in the vicinity of influenced area.

112. Plants and Ground Water : The dependence of plants on ground water in contrast to the ability of other to survive on occasionally rainfall was first pointed out by O.E.Minzer in 1923. He gave the name Phreatophytes to plants that

use water from the zone of saturation; Xerophyte to drought resistance plants and halophyte to salt resistant plants.

Typical species of phreatophytes prosopis grandulosa (mesquite), rabbit brush etc. Typical species of xerophytes are a triplex confert folia (shad scale), winter fat to absorb water from the soil the plant sap must have higher osmotic pressure and therefore a higher salt content than the soil water. In this way, plants are useful as indications to locate the sites for ground water structure.

The depth of ground water can be estimate from the known depth of the penetration of the roots. Hall ophitic plants are only useful in soviet union for location buried salt domes. The directional trend of broad leaved trees, grassy area in grassless lands and grass less area in grassy land are also suggestive indicatives for locating the ground water.

113. Plateau : Any elevated area of relatively smooth land. Usually the term is used more specific to denote an upland of subdued relief. In most instances, the upland is cut by deep but widely separated valleys or canyans. Small plateaus that stand above their surrounding on all sides are often called as table, table lands, or mesas.

114. Plutology : This covers the physical methods of studying the solid part of the earth. It has got four divisions.

i. Geodesy : This is the science of the shape and size of the earth. It covers mass distribution as covers by measurement by gravitational and centrifugal field.

ii. Geo Thermometry : This deals with the earth's heat. It is concerned with temperature variations and of heat generation.

iii. Seismology : This is the science of earthquakes and ground vibrations. It is also mainly concerned with the study of earth's interior.

iv. Tectono physics : It is also called as geodynamics. This is the science of the rock deformation. It covers mainly tectonics. It studies the broader structural features of the earth and the causes.

115. Plutonic Rocks : Plutonic rocks occur in large intrusive masses (bath lites etc., they format great depths and are often referred to as abysal rocks generated from large bodies of magma which has cooled slowly. They characteristically show a phaneritic holo crystalline structure.

116. Porphyroblast : A relatively large crystal formed in a metamorphic rock. The presence of porphyroblasts give the rock a porpyroblastic texture. Minerals found as prophyroblasts are biotite, garnet staurolite, kyanites.

117. Positive Beds and Negative Beds - For Ground Water : Positive beds are those which facilitate the downward movement of water to form ground water for its development. In this regard, formations such as sand beds, sand stones, laterites, conglomerates may be exemplified. In these formations, the pore spaces are wider enough with inter connected openings rendering the downward movement of ground water.

Negative beds are those which retard the downward movement of ground water. Hence the precipitated water accumulates only in surficial layers whose pore spaces are not favourable for the movement of water because of their minute size. Clay, silt stone may be exemplified in this category.

As a matter of fact, the clay, has higher porosity, but the pore spaces are not wider enough to facilitate the ground water movement.

118. Pyroclastic Rocks : Rocks of extrusive (volcanic) origin composed of rock fragments produced directly by explosive eruptions. Pyroclastic rocks may represent a comminuted and scattered older rocks (volcanic and plutonic etc.)

119. Radioactive Minerals and Decay : The so-called radioactive minerals loosely comprise species that contain uranium or thorium as essential part of their chemical composition.

Among with other elements in solid solution. The principle uranium mineral from the point of their economic importance are the oxide urananite and pitchblende.

The radioactive decay of the uranium and thorium present in minerals is accompanied by the emission of particles electron and y-radiation. (x-rays) The crystalline structures of minerals containing uranium and thorium are broken down impact or entirely by the internal absorption of radiation. In the final stage of radiation damage the crystal may become transformed into an amorphous glassy body that is optically isotropic does not diffract x-rays. Such minerals are said to be metamoct. Lead accumulates in the radioactive decay, since it is the end product of uranium and thorium.

120. Radioactivity Exploration : Natural radiation from the earth especially of gamma rays is measured both in land surveys and air borne surveys. The principle radioactive elements are uranium, thorium and potassium.

The Geiger counter and scintillation counter are instruments generally used to detect and measure the radiation.

121. Radiolarian Earth : A porous, earth un consolidated sediment formed from the opaline silica skeletal remains of "radiolarian". It is formed from radiolarian oozes that accumulated on the deep ocean floor. The radiolarian earth and radiolarites are white and cream coloured.

122. Rapakavi Granite : A term originally applied to those granites with abundant large crystals of potash feldspar (orthoclase and microline) commonly mantled by sodic plagioclase (oligoclase or albite) and in a matrix of quartz, potash feldspar plagioclase and, biotite and horn blende. The term rapakavi is now used to any granite with relatively large mantled crystals of potash feldspar (rapakavi structure) best known are the immense bodies of precambrain rapakavi granite in Finland and Sweden.

123. Regional Metamorphism : Igneous magma of high temperature mat penetrate into sedimentary rocks, it may reach the surface or solidify in the form of intrusive bodies (plutonic) heat from such bodies spreads into the surrounding sediments, and the heating up will result in a mineralogical and texture reconstruction known as "contact metamorphism".

The width of the thermal aureole varies as per the size of intrusive body. Ex: hornfels horn stones due to contact metamorphism of stratified rocks.

Hornfels are "Silcified" sediments.

124. Remote Sensing : Measurements of natural and induced electromagnetic radiation made from high flying air-craft, and earth satellites are refer to collectively as remote sensing. This comprises both the observation of natural radiation in various spectral bands including both visible and infrared radiation, such as by photography and measurements of the reflectivity of infrared and radar radiation.

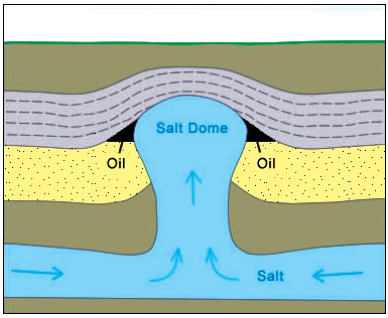
125. Rift Valley : An elongated, relatively narrow depression caused by the subsidence of a crust all block between zero or more faults. The boundary faults are steepy inclined down towards the down throw block. When the direction displacement has been arcertained, it indicates that dislocations are gravity faults. Thus rift valleys are the surface expressions of large graben.

Rift valleys are associated with many mid oceanic ridges where they are interpreted to be graben in uplifted segment of oceanic crust has split apart and new crust is forming.

126. River : A water stream of natural origin which flows across the surface of a continent or island. A rive is part of a river system which drains a topographically related section of land surface known as river basin. The system begins in the precipitation which falls on a rock, soil or vegetation covered surface and immediately becomes surface run-off or appears as snow or ice-melt water or underground drainage. A river ends in a mouth where it discharge into a drainage, a dry basin of interior drainage, inland sea, or the ocean.

Rivers flow in channels or water courses and develop many distinctive valley features by erosion and deposition. Rivers may be described by the pattern of the system which is attributed its volume of discharge, and the nature of water zone. Most of the rivers are part of dendritic drainage patterns, but some rivers in radial, angular, rectangular based on the existing geological structures.

127. Salt Dome : An intrusive body of rock salt which has penetrated large thickness of overlying sedimentary rock. Salt domes are distinguished from other geological deformation in their structural patterns of elliptical or circular dimensions salt domes are known along gulf coast of USA.

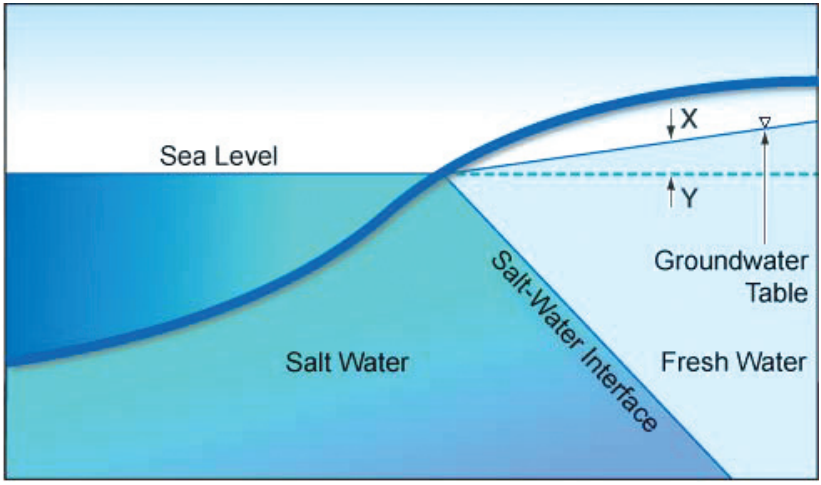


128. Schist : A large group of rocks which by deformation during regional metamorphism have acquired schistocity more or less perfect cleavage along which they easily split up in flaggy slabs. There are orthoschists derived from igneous rocks and para schist derived from sedimentary rocks at greater depths, differential movement and as a result the constituent minerals of the rocks acquires a spatial arrangement as per the alignment of the flakes.

129. Sea Mount and Guyot : A seamount is an isolated submarine mountain rising 3000ft or more above the ocean floor in the pacific basin, there are atleast 10,000 such mountains, which occur as volcanic peaks or ridges or rises and individual peaks.

Flat topped seamounts are called guyots or table mounts. They are present on all ocean floors, but are most common, in the pacific. Bottom samples dredged from several guyots include reef corals and rounded volcanic cobbles. Both the coral and volcanic debris indicates that the flat tops were once at sea level though they are now at 1000-7000ft below the ocean surface. Thus guyots are ancient islands which were truncated at sea level by erosion.

130. Sea Water Intrusion : Sea water intrusion is a serious problem for the coastal aquifers. Two german scientists namely geyben and hersberg studied this problem and established the concept based on differential densities of sea and fresh water which floats on the former. During the pumpage ground water, the sea water intrudes in land along inter face following the rate of density differences according to which the fresh water accumulates 40 time the water table connected to MSL.



As the ground water is pumped out, the sea water moves inland as per the accumulations along the interface and hence, time schedule has to be followed in the utilization of ground water from coastal aquifers.

131. Sediments of Chemical Deposition : The chemical sediments are formed by the reactions between the dissolved component in water of the environment to form the precipitates

The precipitation may be in organisms or it may take place by the action of organisms such as molluskas which secrete calcium carbonate shells.

A great many invertabrates are able to extract calcium carbonate from sea water for their shells after death, the shells accumulate to form sediment.

Carbonate Sediments : Many invertebrate are able to extract calcium carbonate from sea water for their shells. After death, the shells accumulated to form as sediment. In some areas very fine grained calcium carbonate mud accumulated on the bottom. The mud when it is lithified, it becomes a dense finely crystalline limestone.

Dolomite lime stone : Silicious sediment consists of largely chemically precipitated silica. Inorganic precipitation of silica around the hot springs as silicious sinters. Chert is a silicious sediment that occurs chiefly as nodules.

Ferruginous Sediments : They are the iron rich sediments formed in reducing environments where ferrous compounds predominant native sulphur is found in some sediments.

The Carbonaceous : Sediments are formed by the accumulation of vegetable and organic debris. The most important deposits are peat and coal. The preservation of the organic material depends on rapid burial or lack of oxygen in the environment. Peat deposits are formed in fresh water swapes, bogs etc. Vegetation is transformed into peat and then coal by a combination of bacterial and chemical decay and alteration. The end result of this process, called incoalation is the reduction of proportion of oxygen and hydrogen and enrichment of carbon.

132. Sediments of Physical Deposition : Clastic or detrital sediments are those that have been deposited by the mechanical action. It is most convenient to subdivide on the basis of particle size.

Coarse Grained Clastics : They are large particles such as pebbles, cobbles and boulders, which are carried out by high velocity currents. The coarse clastics gravel, and their indurated equivalents conglomerates are transported by rivers in times of flood on land, they may also be transported by landslide, mudflows etc.

Medium Grained Clastics : These are sand and their consolidated equivalents. Sand stones ranging in diameter upto 2mm from 1/16mm. Most streams and rivers have velocity components to carry this sized particles. Windblown sands are common and tend to be fine grained ¼ or 1/8 mm. Sand accumulated as river bars, dunes, alluvial fans.

Fine Grained Clastics : These are silts and mud stones. As their indurated equivalent shales and silt stones

and mud stones. As their particle size is so small, they may be easily carried out by slow-currents in suspension.

133. Seismology : The science of strain wave propagating in the planets and their naturally occurring satellites strain waves propagation in the interior from a source and are recordedly seismographs distributed over the surface. From wave analysis it is possible to infer the sub surface structure and also mechanism of the source.

An earthquake is the abrupt release of strain through the action of natural forces within the earth. The depth of occurrence of the earthquake focus the region of the earth provides basis for classification shallow focus earthquakes occur down to 60km intermediate at depth range of 60m to 300km and deep seated focus between 300 to 700km most earthquakes are below 60km. At shallow depths the intensity is measured on rictor scale upto 10.

134. Siliceous Sinter : A porous silica deposit formed around the springs, the perennial sources of non-stopping form of water. It is white to light gray and sometimes friable greysirite is a variety of siliceous sinter formed around geysers. The siliceous sinters are deposited as the hot subterranean waters coal after issuing at the surface and become super saturated with silica that was picked up at depth. The sinters are frequently deposited on the algae that live in the pools around the hot springs.

135. Soil Erosion : Soil erosion is that physical process by which soil material is weathered away and carried down, Grade by water or moved about by wind. Two categories of erosion are recognized. The first called geologic erosion, is

a natural process that takes place independent of man's activities. This kind of erosion is always active, wearing away the surface features of the earth. The second kind, referred to an accelerated erosion occurs when man disturbs the surface of the earth. Quickens the phase of erosion in any way.

A. Types : Erosion by running water is usually recognized in the one of three forms : Sheet erosion, Rill erosion, Gully erosion.

i. Sheet Erosion : The removal of thin layer of soil more or less uniformly from the entire surface of an area is known as sheet erosion.

ii. Rill Erosion : During heavy rains, run-off water is concentrated in small stream-lets or reulets. At the volume or velocity of water increases, it cuts narrow trenches called Rills. Erosion of this type can remove large quantities of soil and reduce the soil fertility.

iii. Gully Erosion : This type of erosion occurs where the concentrated run-off is sufficiently large to cut deep trenches or where continued cutting in the same groove deepens the incision.

136. Soil Texture and Physical Properties of Soil : Soil texture. About one half of the total volume of mineral soils consists of solid matter of which 80 to 90% inorganic and 1-20% is organic material. The inorganic fraction consists of rock and mineral particles of many sizes and shapes. They are classified into five major sized groups. Called "separates" the two largest separates are stone and gravel.

Stone particles are greater than 76mm and gravel 2-76mm sand particles are 0.05 to 2mm in diameter. Sand particles may also be graded as coarse, medium, fine and very fine. Silt has particle size 0.002-0.005mm in diameter. Clay is the smallest of the soil particles whose size is less than 0.002mm.

The physical properties of soil are important in agriculture because of their influence on plant growth and on the manage requirement of the land. They influence plant growth from seedling to maturity in regulating the supply of air and water and heat. The absorption of plant nutrients by roots is dependent on the available supply of oxygen, water and heat. Thus physical properties in directly regulate the nutrition of plants and their response to fertilization. Physical properties also determine the kind, amount and ease of tillage, the run-off and erosion potential.

137. Soils : Freely divided rock derived material containing a admixture of organic matter and capable of supporting vegetation. Soils are independent natural bodies, Each with a unique morphology resulting from a particular combination of climate, living plants and animals, parent rock materials, relief, the ground water and age. Soils supports plants, occupy large surface of the earth. And have a shape with depth, width and breadth.

138. Solar System and Planets : The solar system consists of a single star (Sun) it is system of nine planets and their satellites (moon) and numerous asteroids. The solar system

is only one of billions of star centered system in the universe. All stars of star groups, and nebulae occurred in clustered groups called galaxies.

The solar system is situated near the outer edge of the space like disc shaped milky way galaxy. The nine planets are distributed about the sun at orbital distances more than 99% of the total mass of the solar system is concentrated in the sun. All the planets except Uranus rotate about their axes in a direction parallel to the axial rotation of the sun.

139. Special Geo-Technical Problems : In arctic zones, structural built on perma frosted soils may be heaved or may cause thawing and subsequent disastrous settlement. The growth of permafrost upward in earth dam seriously affects their stability and permeability characteristics. Obtaining natural construction materials in perma frosted area to require the thawing the barrow area to permit efficient excavation, perma frost in rock seldom will cause foundation difficulties. In planning reservoirs, it is essential to evaluate their water tightness, particularly in areas containing sulphate carbonate rock formations and lava flows. The formations generally contains extensive system of caverns and channels they may or may not be filled with clay like material or water. Sedimentation studies are required for the design of efficient harbours or reservoirs because soil carried by the moving water will settle and block or fill these structures. A geo hydrologic problems when the interstices or pores contain water as part of the soil or rock. When the structure load compresses the foundation material the resulting compressive forces on

the pore water can produce undesirable uplift pressures on the base of the structure. The possibility of excessive seepage or piping can be learned by appropriate tests during the boring program.

Civilian and military constructions may be designed to minimize the effect of nuclear explosion. The most effective protection is to place the facility in a hardened underground excavation

140. Spring : A spring is a natural discharge point where ground water issues from soil or rock in concentrated flow.

141. Stalactites and Stalagmites : Stalactites and stalagmites, drip stone and flow stone are travertine deposits in limestone caverns formed by the evaporation of waters bearing calcium carbonate. Stalactites grow down from the roof of the and tend to be long and thin with hallow cores. The water moves down the core and precipitates at the bottom. The stalactites are banded concentrically to the centre.

Stalagmites grow from the floor up and are commonly found beneath stalactites they are formed from the evaporation of the same drip of water that forms the stalactites. Stalagmites are thicker and shorter than stalactites and have no central hallow core.

Drip stones and flow stones are travertine accumulations of much the same origin as stalactites and stalagmites but are irregular sloping walls or surfaces of the cave.

142. Staurolite : The neso silicate mineral (ferrous alluminium silicate) that crystallizes in the orthorhombic system. It is frequently in crystals. Usually a combination of the vertical prism with the basal and side pinacoid. Equally common are two types of cruciform penetration twins.

143. Stratigraphy : The branch of science of geology that studies layered or stratified rocks mainly sedimentary rocks and also to the extent of layered igneous and metamorphic rocks formed from sedimentary rocks. It deals with the observed interrelations of the layers of such rocks and with the historical conclusions that can be inferred from those interrelations.

The first task of stratigraphy is the description of local sequence of strata : From these descriptions, local geologic strata may be inferred by using law of superposition, which state that in a local sequence of rock layers, the lower ones are the older. First deduced by N. Steno(1669). The law amply established by studies of sedimentation.

The second task of stratigraphy is the correlation of these local sequences. That is, the determination of their time relations etc. Correlation may be done by means of fossil, flora and fauna that occurred many parts of the world.

The Third task of stratigraphy is the interpretation of geologic history of the earth from the scattered data of local sequences and criteria of correlation. Based in the clues of sedimentation, sedimentary petrology and plants and animal ecology which gives interpritation as per the law of uniformity.

144. Strontianite : The mineral form of strontium carbonate, usually with some calcium replacing strontium. It characteristically occurs in veins with barite or celestite or as masses in certain sedimentary rocks.

Strontianite has orthorhombic symmetry and the same structure as aragonite. It is normally prismatic with the development of pseudo hexagonal form or also be massive. It may be colourless or grey with yellow, green or brownish tints.

145. Structural and Stratigraphic Anticlines and Synclines : A fold in layered rock in which the strata are inclined down and away from the axes. The simplest anticlines are symmetrical, but in more deformed formations, they may be asymmetrical anticlines. Both stratigraphic and structural anticlines and synclines are similar. In case of synclines, the beds are inclined down and toward the axis.

Stratigraphic synclines are those which regardless of their observed forms, are inferred from stratigraphic data. The structural synclines are those which have synclinal form regardless of their stratigraphic relations.

146. Submarine Ridges : There are two type of oceanic ridges seismic and aseismic. The mid oceanic ridge system is of the former type and is the longest single feature on the earth. It is more than 8000km long and completely encircles the globe. In many cases, ridge is offset by large fracture zones; along which seismic activity is generally higher thane elsewhere on the ridge system. Over the entire length, the ridge is characterized by a narrow zone of shallow focus earthquake epic enters. The tops and flanks of seismic ridges have been dredged and have yielded basaltic rocks with some inclusions of gabbroic materials. In addition to the mid oceanic system, there are other oceanic ridges, but they are seismically inactive.

147. Surface Deformations from Eruptions : Measurements at certain volcanoes have demonstrated that the entire volcanic mountain swells and shrinking apparently in response to changes in conditions beneath the volcano. The deformation may be measured by tilt meters which are capable of detecting changes in inclination measured in fractions of a second of arc. The mountain swelling before eruption and shrinking during are immediately after it shows direct close relationship to eruptions. This suggests swelling as a result of injection of magma into some sort of reservoir in or beneath the cone and shrinking as a result of drainage of the reservoir.

This is evidenced by the fact of many instances elsewhere. Volcanic earth vibrations in many eruptions preceded by numerous earthquakes. Other volcanic earth vibrations are termed harmonic tremors which go continuously for many hours weeks etc. volcanic explosion also produce shock waves in the atmosphere.

148. Syngenitic Minerals : Those minerals were formed at the same time of the enclosed rock are called syngenitic minerals. And those that were introduced into pre-existing rock are called as epigenetic.

149. Types of Volcanic Eruptions : The temperature of eruption magma has been measured in lava flows and directly in volcanic vents by means of the thermocouples and optical pyrometers. The viscosity of flowing magma or lava has been measured by means of penetrometers. (instruments that measure the rate of penetration into liquid of a slender rod under given strength of thrust).

The character of a volcanic eruption is determined by the viscosity of the liquid phase of the erupting magma and abundance and condition of the gas it contains viscosity is in term affected by the factors such as chemical composition and temperature of the liquid, the load of solid crystals and xenoliths it carries and the gas.

Types or eruptions are designated by the name of volcanic or volcanic area.

A. Hawaiian Eruption : Eruptions of the fluid lava in which relatively small amounts of gas escape freely with little explosion are given this designation. Most of the lava

is extruded in thin flows that spread distances of several miles from their vents.

B. Strombolian Eruption : These somewhat more explosive eruptions of lava with a greater viscosity produce larger proportion of pyroclastic materials.

C. Volcanian Eruption : Most explosive volcanic type. Angular blocks of viscous or solid lava are hurled out accompanied by voluminous clouds of ash without much lava or flow.

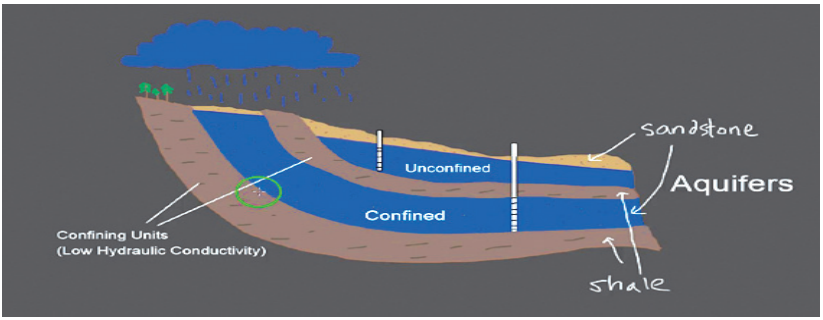
D. Peleean Eruption : These eruptions are characterized by the heaping of viscous lave over and around the vents to form a steep sided hill or volcanic dome.

E. Plinian Eruptions : These paroxysmal eruptions of great violence are characterized by the voluminous explosive ejections of pumice and ash flows.

F. Ultra Volcanism Explosions : These are some low temperature explosions of this type throughout fragments of old volcanic or non-volcanic rock accompanied by little or no magmatic materials.

G. Phreatac Explosion : Volatilization of ground water when it come in contact with hot lava or hot rocks in the walls of the volcanic conduit causes these occasionally violent disturbances.

150. Unconfined aquifer : A. This is permeable bed only partly filled with water overlying a relatively impervious layer. The water in this aquifer is called phriatic.



B. "Incase of confined aquifer, it is bounded by impermeable strata such as shale (below and above) and the artesian pressures are developed rendering the aquifer as flowing well zone"

151. Uniformitarianism : Uniformitarianism locates a non-catastrophic view of the earth and its features. Rocks change in the fossils record and geological features such as landscapes and structures are thought to be produced by the same natural processes and laws which operate at present to modify the earth. These processes and forces also operate with essentially the same intensity today as they had in the past. This concept had replaced catastrophism as the governing doctrine of geology by 1850. And that change led in turn to the development of geology as modern science.

152. Vertical Distribution of Ground Water : Virtually the vertical distribution of ground water may be studied under two concepts namely from the surface to downward.

a. Zone of aeration or zone of un-saturation

b. Zone of saturation

c. The zone of aeration may be subdivided into three parts.

i. Soil moisture zone – soil moisted with water and air.

ii. Vaduse or intermediate zone which contains air and water molecules suspended by gravitational force.

iii. Capillary fringe : Which rises from the water table through the tubular structures of the pore spaces of the existing rock structure.

d. Zone of Saturation : Below the capillary fringe all the pores are filled with water saturating entire zones the upper surface of this zone is called water table.

153. Warping of Earth's Crust : Gentle bending of the earth's without pronounced folds or dislocations the earth's crust is being warped at measurable rates to be associated with several causes observed by geodic and geological surveys.

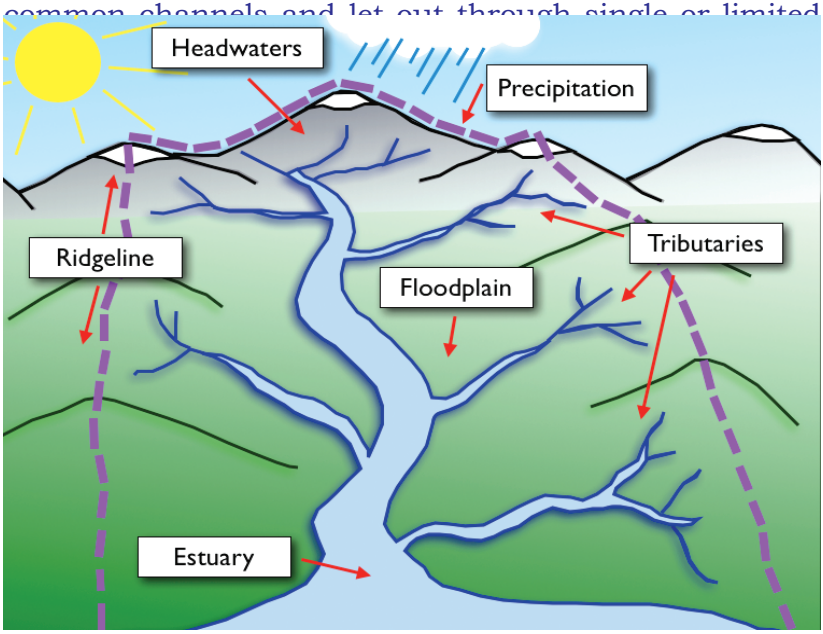
Melting of former ice sheets has led to uplift as in northern Finland (476 in past 9950 years) uplift is still proceeding at a maximum rate of 1-3cm/year.

As a result of loading in details and sedimentation, many coasts sinking. For example, the coast of Holland, and atlantic and gulf coast of north America are sinking at rates of obout 0.5cm/year.

Mountain uplift and faulting are causing other areas of Japan and some areas in Pacific coast of North America. Relative horizontal movements of the order of 5km/year are observed in the past at unknown rates occurred in the past at unknown rates as marine sediments are high on many mountains.

154. Water Falls and Rapids : These are impressive, but geologically satisfactory features of a stream. They are present because of a sudden drop in the stream course. This interruption in the profile of the stream is in may instances due to resistant rock which the stream cannot easily remove. Thus Niagara falls is heaped up by a thick layer of resistant dolomite which over lies less resistant shale.

155. Water Sheds : Water shed may be defined as a physiographic unit having definite boundaries with in which the precipitated water will be drained towards the common channels and let out through single or limited



156. Water Sheds - Treatment : The watershed treatment may be considered as the appropriate method for the artificial recharge of ground water. For arresting soil erosion hence harvesting structures may constructed at the proper sites within the watershed area.

I. Trenching : in the upland area, soil erosion is the serious problem due to flash run off which may be controlled by trenching operations on the ridge surfaces arresting the runoff from hill tops.

II. Rock Fill Dams : A rock fill dam is an embankment constructed across a water way using variable sizes of stones. This is a permeable type of permanent or semi permanent structures adopted gulley control. These structures may be viewed as quite economical whereever the loose rock fragments are available.

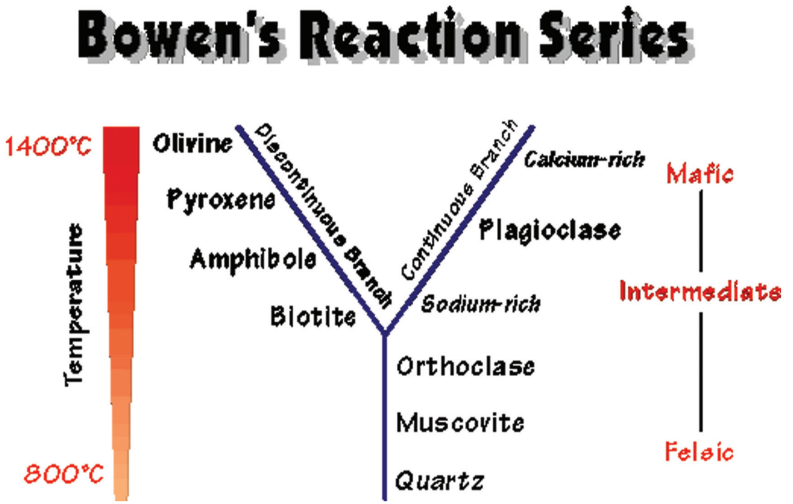
III. Percolation Tank : Where the soils are permeable percolation tanks may be constructed with in the water shed area to store the rain water to get infiltrated into the ground to recharge the area artificially.

IV. Check Dam : Check dam are the structures constructed on flat nallahs with in the watershed area to arrest the water which is meant for recharge the area by sea page.

157. Well logging : A variety of type of geophysical measurements are made in bore holes including self potential, electrical conductivity, velocity of seismic waves natural and induced radioactivity and temperature vibrations. Bore hole logging is used extensively in petroleum exploration to determine the characteristics of

the rock which the bore hole has penetrated and to a lesser extent in mineral exploration.

Bowen's Reaction Series



Bowen determined that specific minerals form at specific temperatures as a magma cools. At the higher temperatures associated with mafic and intermediate magmas, the general progression can be separated into tow branches. The continuous two branches describes the evolution of the plagioclase feldspars as they evolve from being calcium-rich to more sodium-rich. The discontinuous branch describes the formation of the mafic minerals olivine, pyroxene, amphibole, and biotite mica.

The weird thing that Bowen found concerned the discontinuous branch. At a certain temperature a magma might produce olivine, but if that same magma was allowed to cool further, the olivine would "react" with the residual

magma, and change to the next mineral on the series (in this case pyroxene). Continue cooling and the pyroxene would convert to amphibole, and then to biotite. Mighty strange stuff, but if you consider that most silicate minerals are made from slightly different proportions of the same 8 elements, all we're really doing here is adjusting the internal crystalline lattice to achieve stability at different temperatures. Really no big deal.

At lower temperatures, the branches merge and we obtain the minerals common to the felsic rocks - orthoclase feldspar, muscovite mica, and quartz (the banana slug of the mineral world).

Earthquake - Dilatancy

There is a sort of indication which may be visualised as the fundamental signal taking place in the Earth's crust before the occurance of earthquake. This fundamenta change may be attributed to the property of rock called "Dilatancy". Which effects both increase in the volume of the rock and distortional strain. When stress build up prior to fracture numerous cracks of oper up within a rock causing it to swell.

According to the theory of diatancy, stress slowly build up, over many years in earthquake prone area. Eventually on some part of the area, the stress becomes high enough to cause cracks to open, hence dilatancy occurs.

An important consequence of the process is that the layer at the upcoming earthquake, the larger dilatant the dilatant volume and hence the longer the time required for the influx of water. Thus precursors last longer for the larger earthquake.

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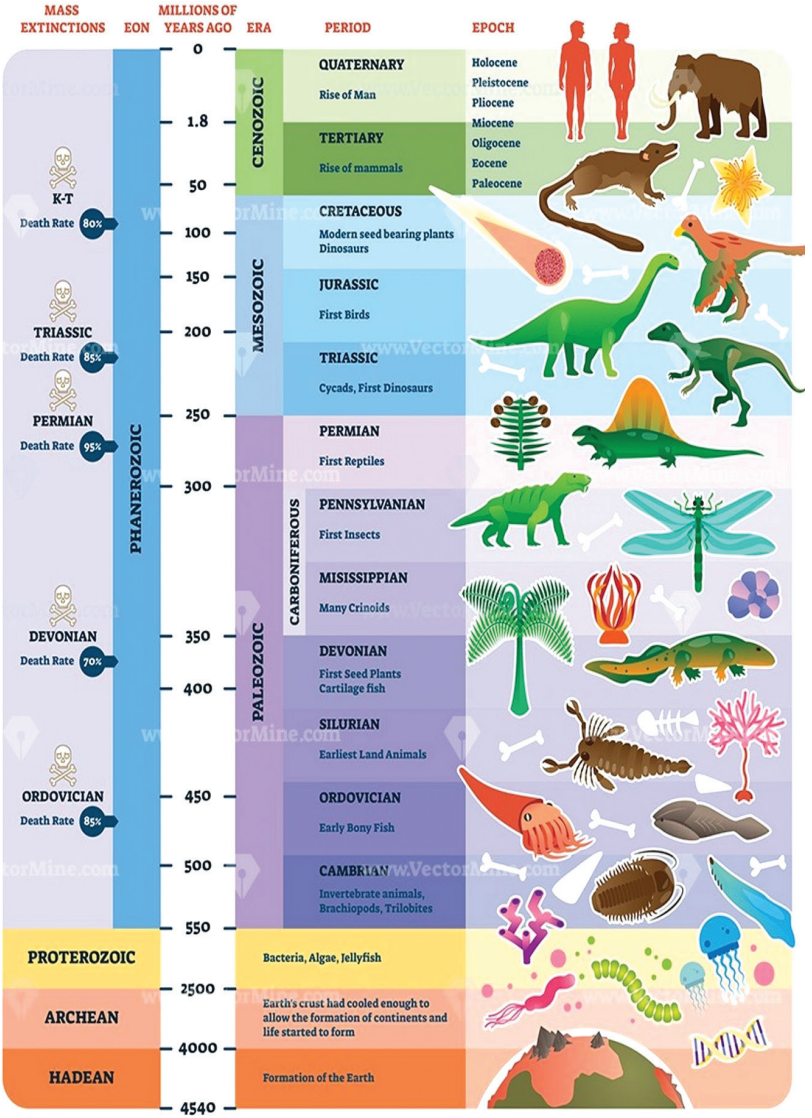
GEOLOGIC TIMELINE



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II. Basic Principles of Hydrogeology

by

1. Ravi Mohan Rao,
   Lecturer in Geology,
   Dept. of Geology,
   VRS & YRN College, Chirala
2. A.Subrahmanyam,
   Head of the Dept. of Geology,
   Hindu College, Guntur.
3. Makkena Anjaneyulu,
   Asst-Director, A.P. Ground Water Dept.

III. "Bhugarbha Jalam"

by Makkena Anjaneyulu,
Asst-Director, A.P. Ground Water Dept.

IV. "Navyandhra Rajadhani - Bhuvignana Prasara Sravanthi"

by Makkena Anjaneyulu,
Asst-Director, A.P. Ground Water Dept.

James Hutton, FRSE

'Father' of Modern Geology

James Hutton FRSE was a Scottish geologist, agriculturalist, chemical manufacturer, naturalist and physician. Often referred to as the 'Father' of Modern Geology, he played a key role in establishing geology as a modern science.

Mr. Anjaneyulu speaking on Conjuctive Use of Both Surface and Ground Waters simultaneously in National Seminar held at Vijayawada on 11-02-2016, Govt. of Andhra Pradesh, Amaravati.

Mr. Anjaneyulu has participated and speaking in "Neeru-Chettu" program held at vijayawada in Tummalapalli Kala Kshetram arranged by Irrigation Department, Govt. of Andhra Pradesh.

Government of Andhra Pradesh
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Organised by
Department of Geology
Sri MAKKENA ANJANEYULU
Retd. Assistant Director, Ground Water Department, A.P.

HINDU COLLEGE
GUNTUR
Dept. of Geology
Guest Lecture :
Sri Makkena Anjaneyulu
M.sc B.E.d
Retd.Assistant Director,
Ground Water Department, Andhrapradesh
03-08-2019
HINDU COLLEGE
GUNTUR

GUEST LECTURE ON GROUND WATER

By Sri MAKKENA ANJANEYULU, A.D. (Retd)
A.P.G.W.D., Govt. of Andhra Pradesh.

(The list of Colleges in which the Lecture was delivered are listed below)

1. S.S.N. College, Narasaraopeta.
2. Y.R.S. and V.R.N. College, Chirala.
3. Hindu College, Guntur.
4. Sir C.R. Reddy College, Eluru.
5. J.V.R. Engineering College, Guntur.
6. Prakasam Engineering College, Kandukur.
7. Mallinani Lakshmaiah Engineering College, S.Konda.
8. Mallinani Perumallu Engineering College, Prathipadu.
9. St. Ann's Engineering College, Vetapalem.
10. KITS Engineering College, Vinjanampadu.
11. Siddartha Engineering College, Vijayawada.
12. Narasaraopeta Engineering College, Narasaraopeta.
13. Eswara Engineering College, Narasaraopeta.
14. Jawahar Bharat Degree College, Kavali.
15. Bapatla Engineering College, Bapatla.
16. Narayana Engineering College, Nellore.
17. QIS Institute of Technology, Ongole.
18. RISE Engineering College, Valluru, Prakasam Dt.

19. Sai Tirumala Engineering College, Narasaraopeta.
20. Krishnaveni Engineering College, Narasaraopeta.
21. Visvodaya Engineering College, Kavali.
22. Tirumala Engineering College, Narasaraopeta.
23. PACE Engineering College, Valluramma Temple, Ongole.
24. S.S.N. Engineering College, Ongole.
25. Buchepalli Engineering College, Chimakurthy.
26. V.V.T.T. Engineering College, Nambur.
27. Chirala Engineering College, Chirala.

This is one of the most sucessful structure constructed with the field knowledge of **Makkena Anjaneyulu** for the benefit of his native place, Chandaluru, J.Panguluru (M), Prakasam Dt.

About Figure Depiction on the Cover

I. Rocky Mountain System :

Southern Rocky Mountains : These mountains consists of uplifted and eroded crustal blocks including both crystalline rocks and sedimentary rocks. Exposing long margins of intervening inter mountain basins and high plateaus. The basins and plateaus are extensively alleviated and are locally fringed with extensive alluvial fan and pediments.

The Rainbow mountains of China are the Earth's pallet.

II. Grand Canyon – View of the curves of the San Juan River Valley in Colorado Plateau : Grand Canyon is the deepest valley in the world. In the figure depicted the curves of San Juan River Valley where it entrenches the Colorado Plateau in the Canyon.

III. Folds : Folds are recognized where layered rock has been distorted into wave-like foul as shown in the figure.